

FIG. 1

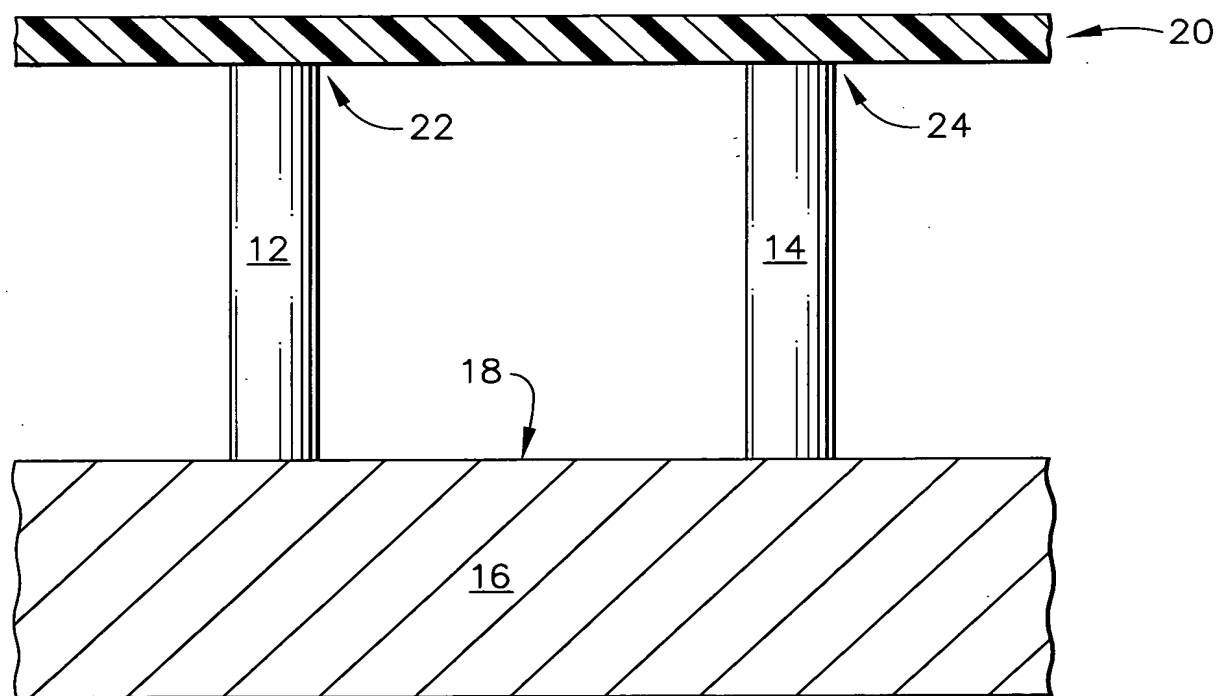


FIG. 2

10

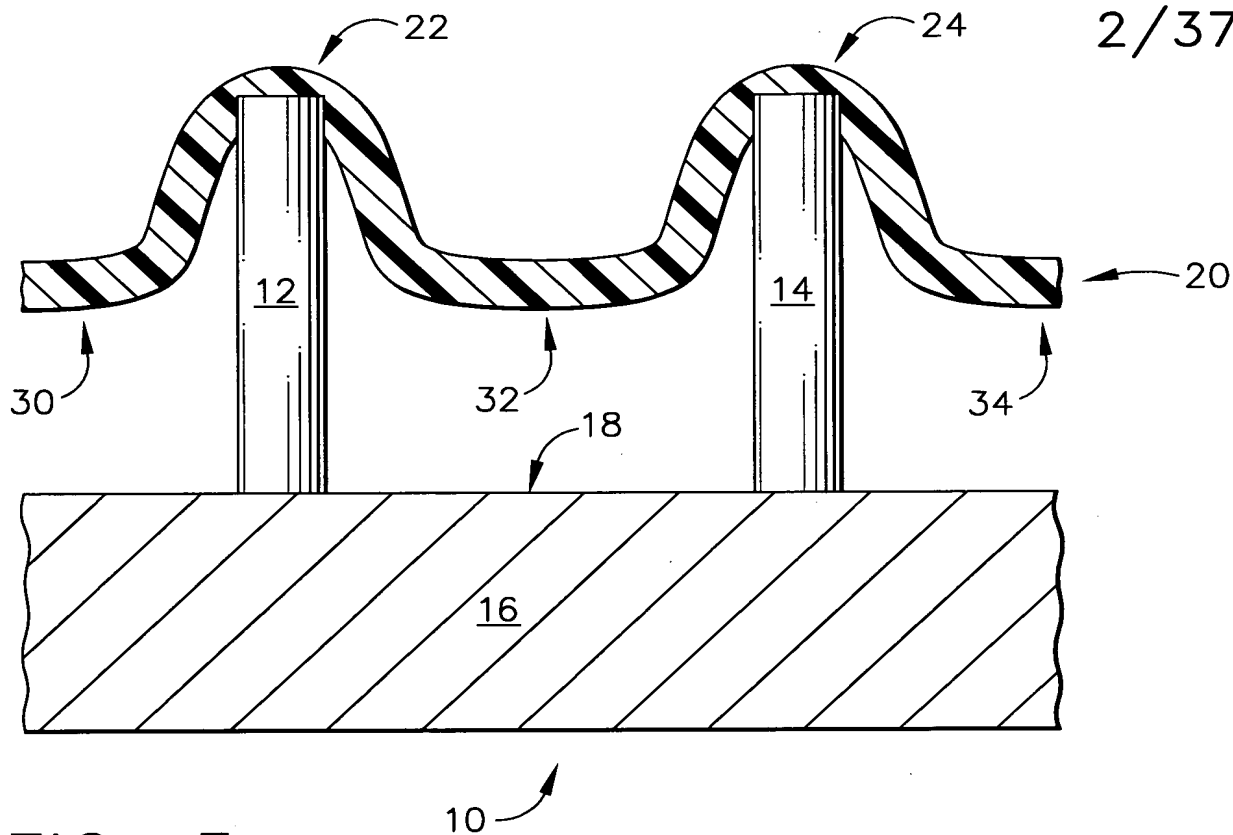


FIG. 3

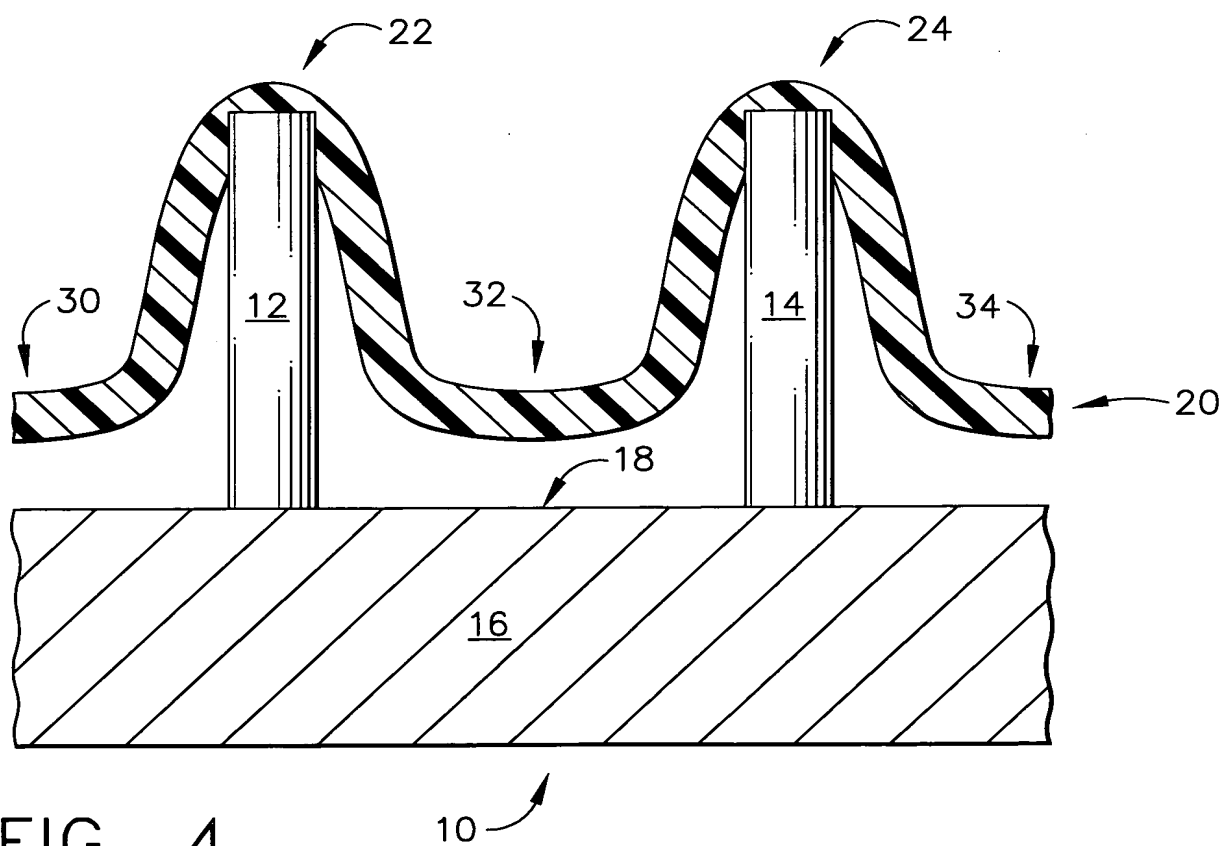


FIG. 4

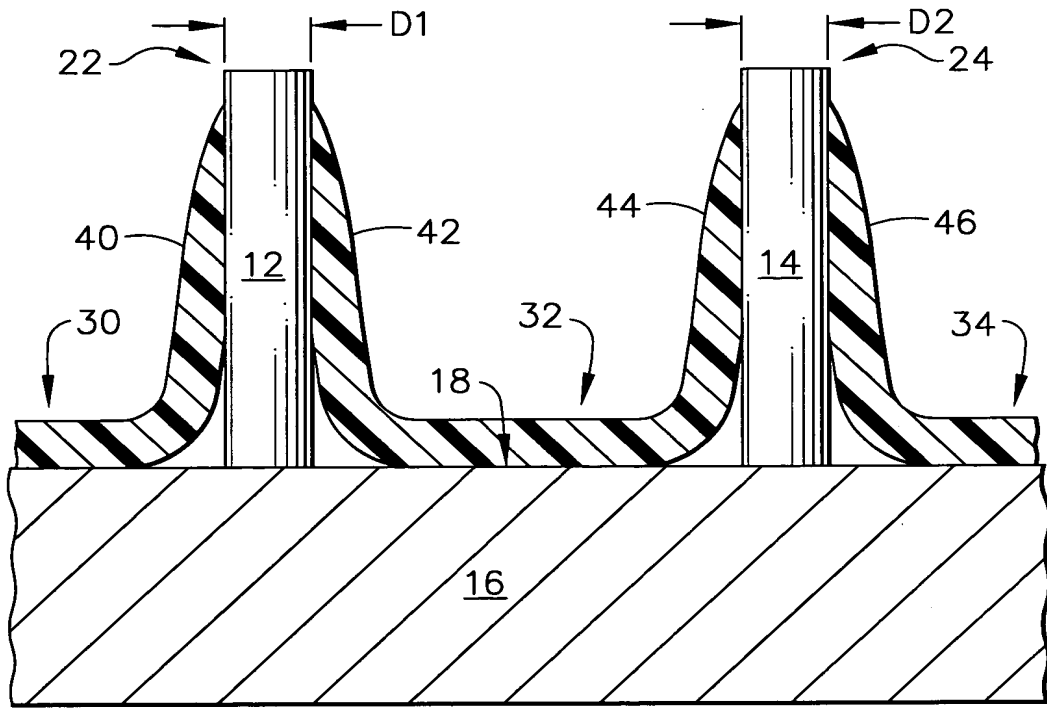


FIG. 5

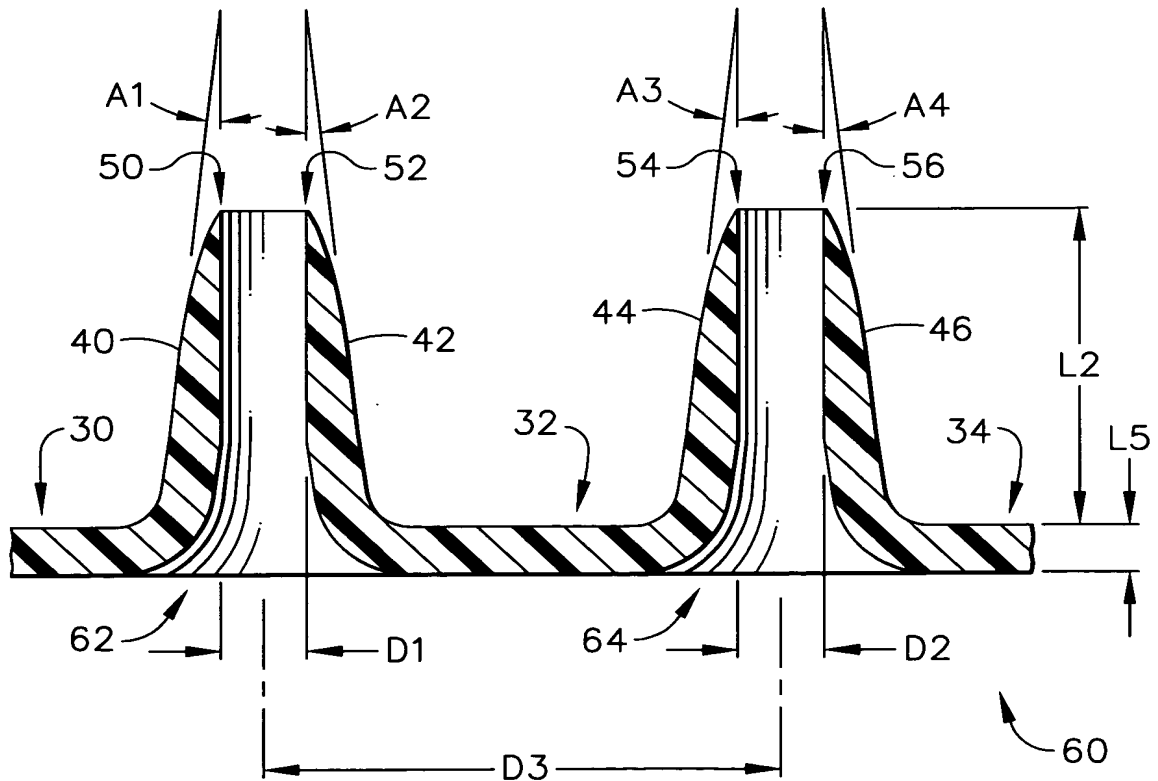


FIG. 6

0580819-052600

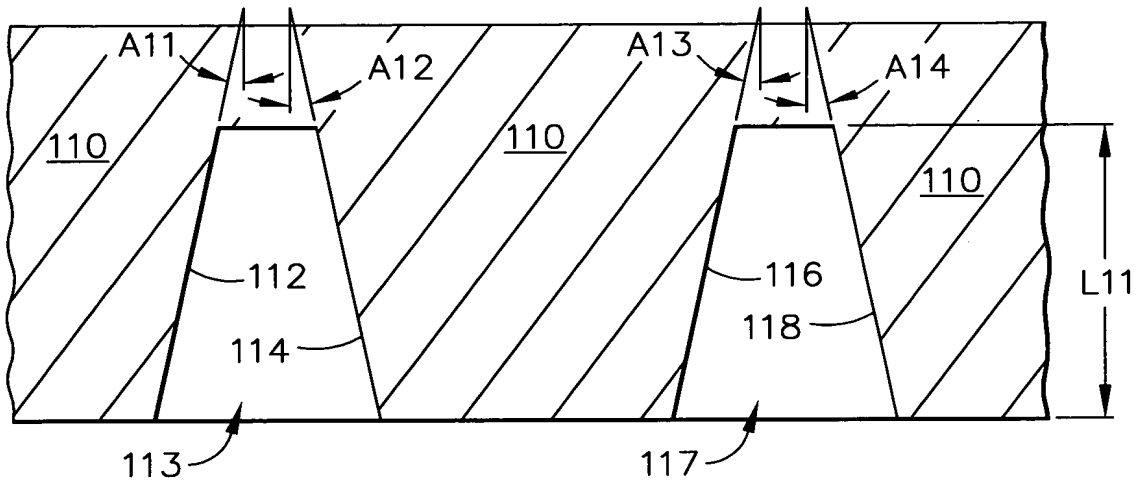


FIG. 7

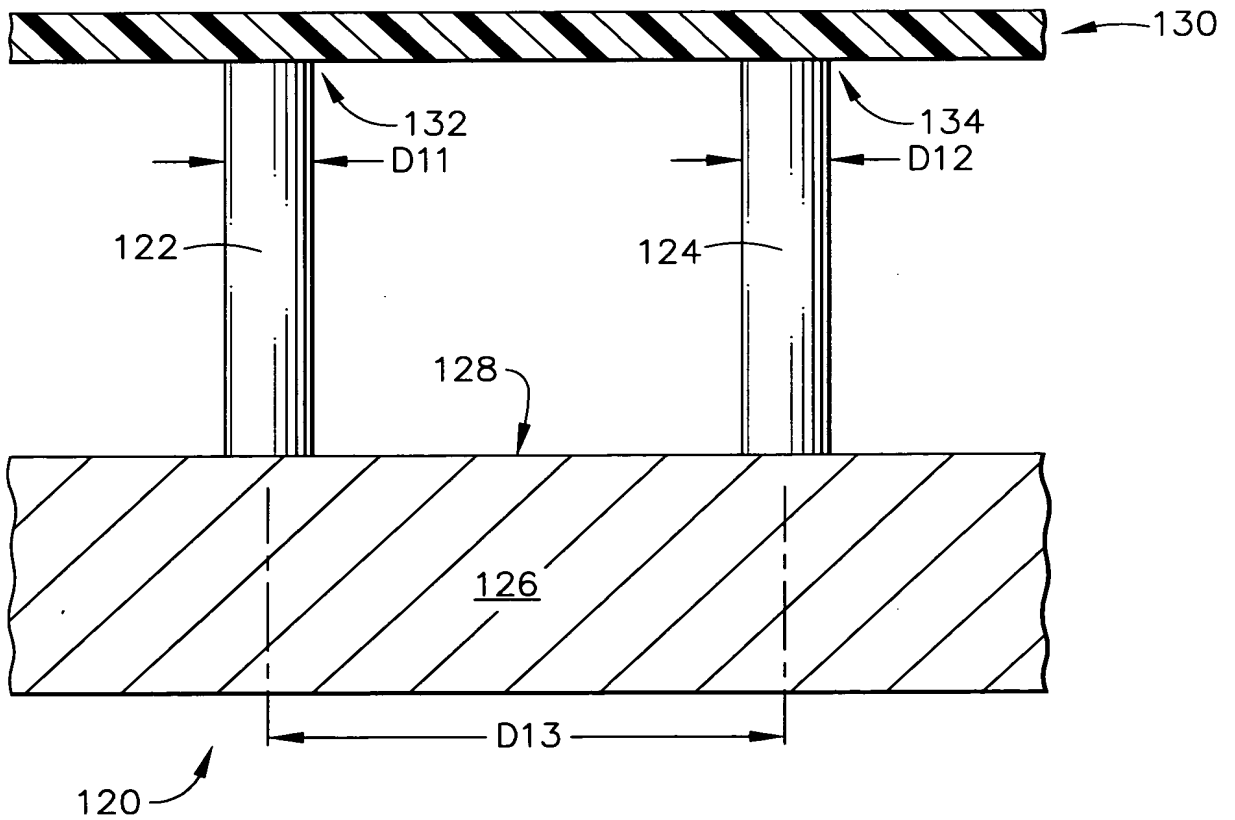
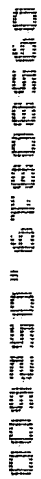


FIG. 8



09060319-050000

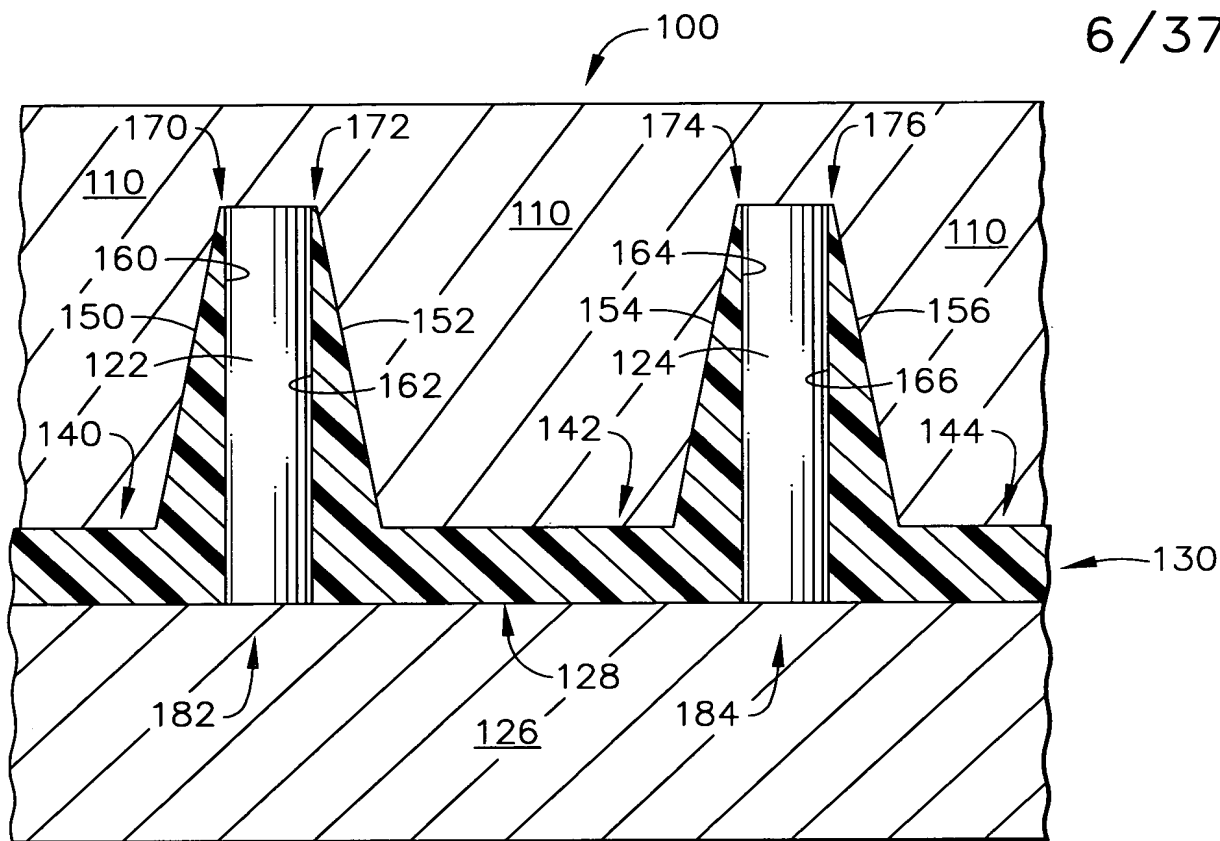


FIG. 10

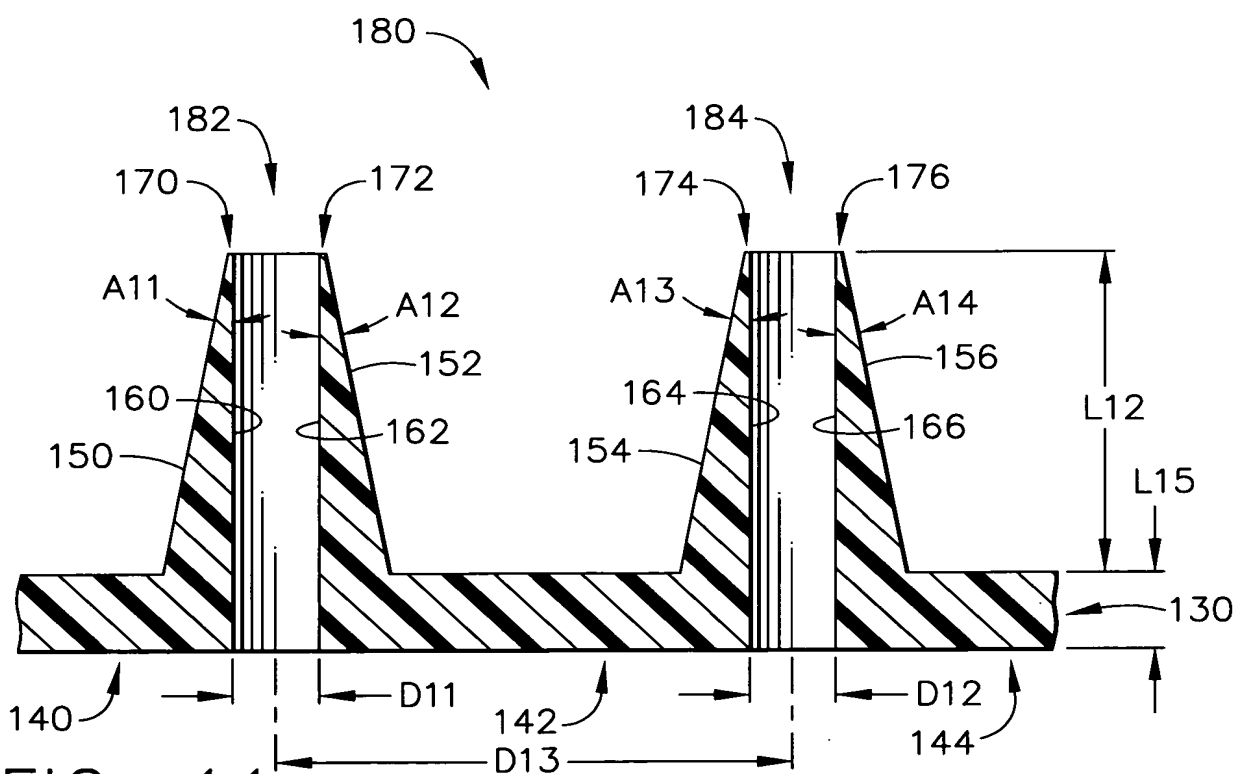


FIG. 11

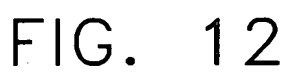


FIG. 12

200

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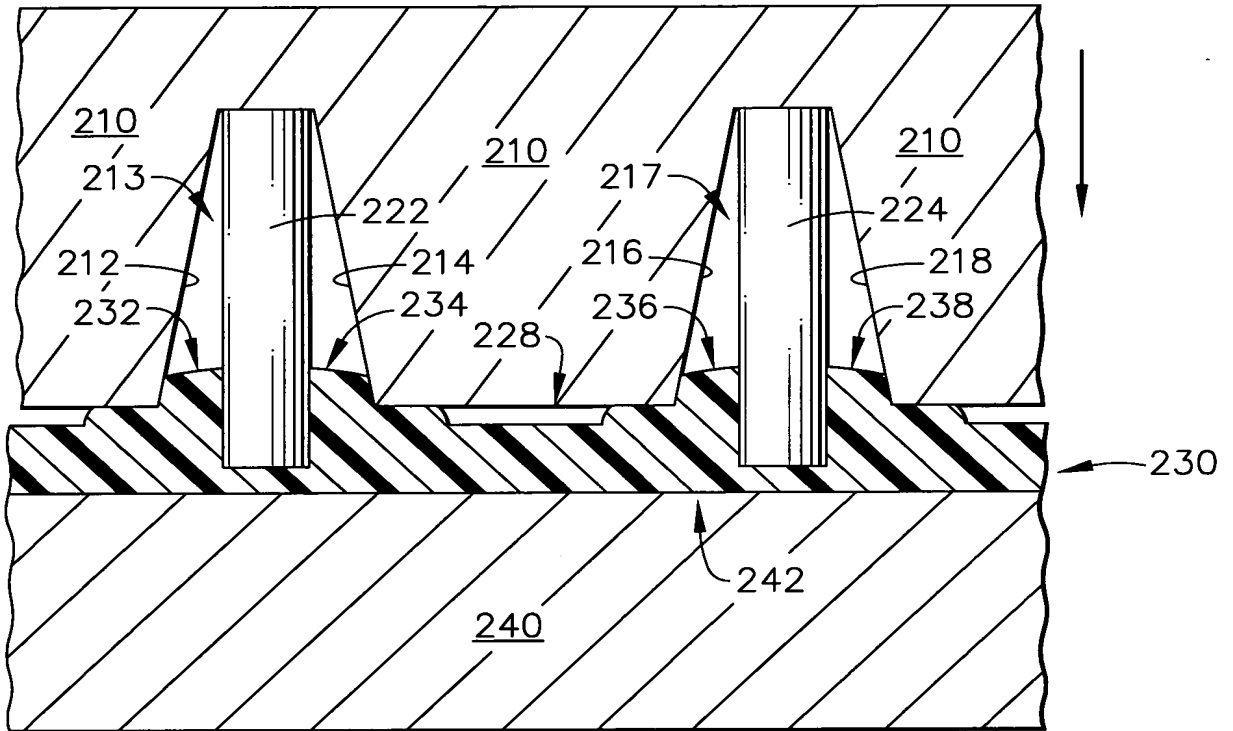


FIG. 13

200

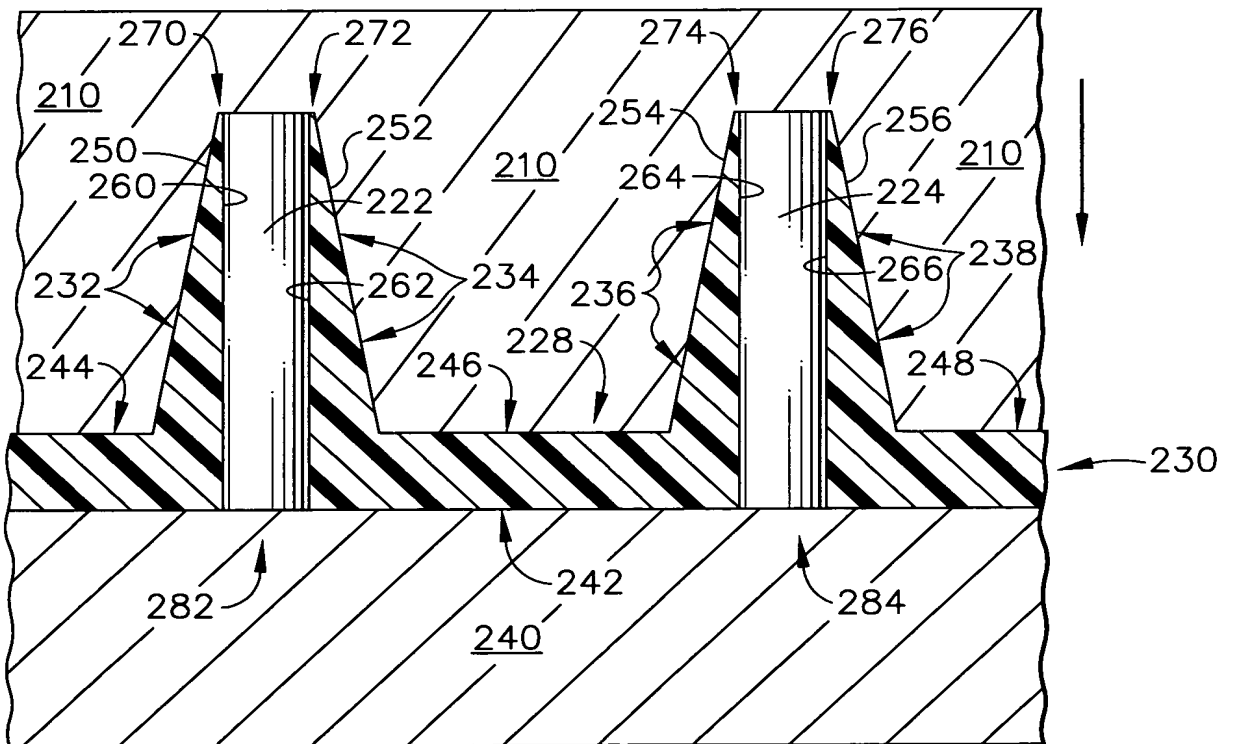


FIG. 14

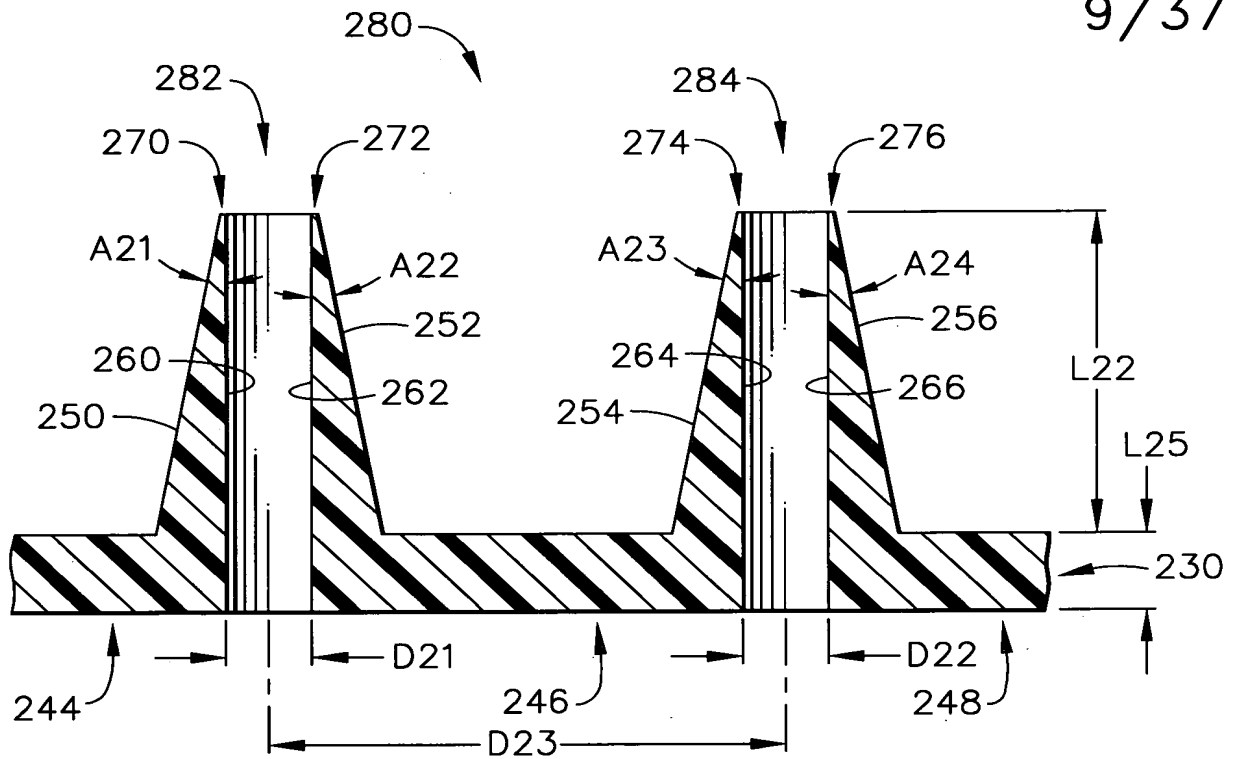


FIG. 15

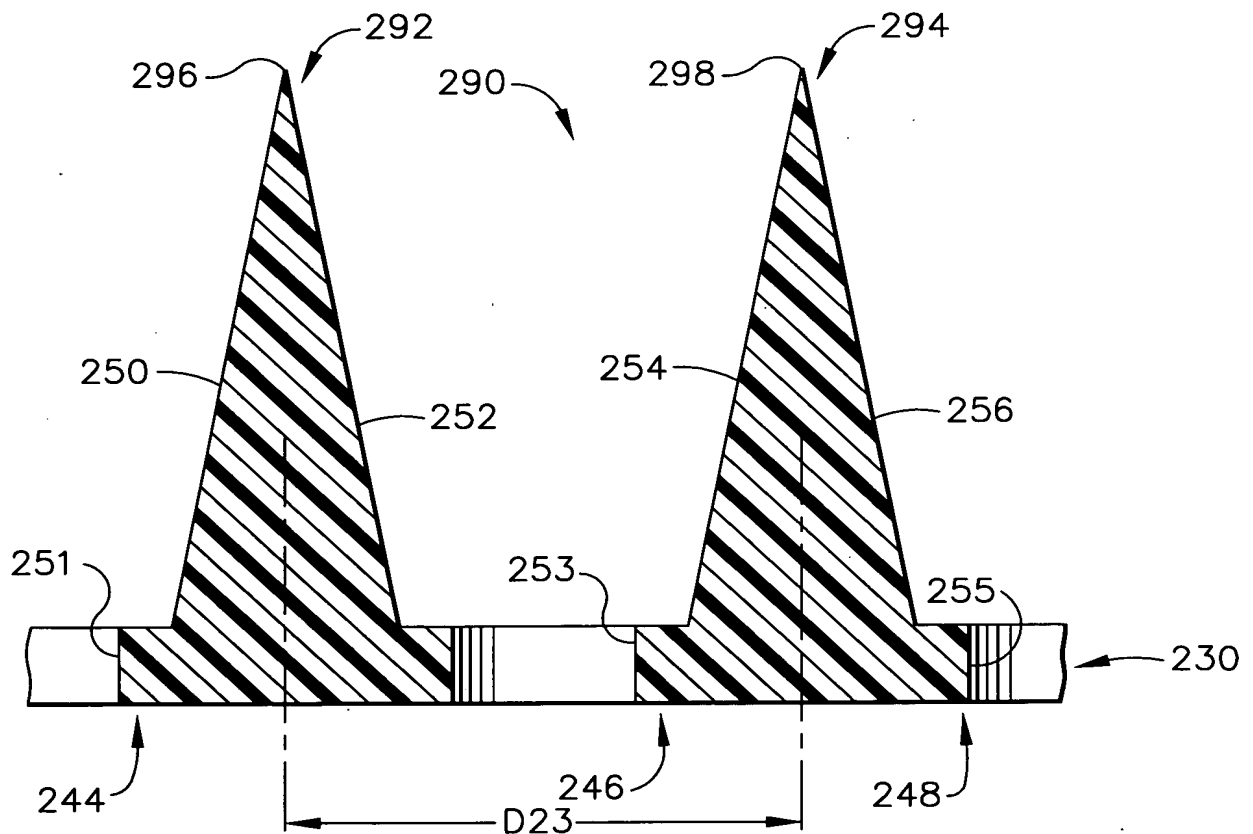


FIG. 15A

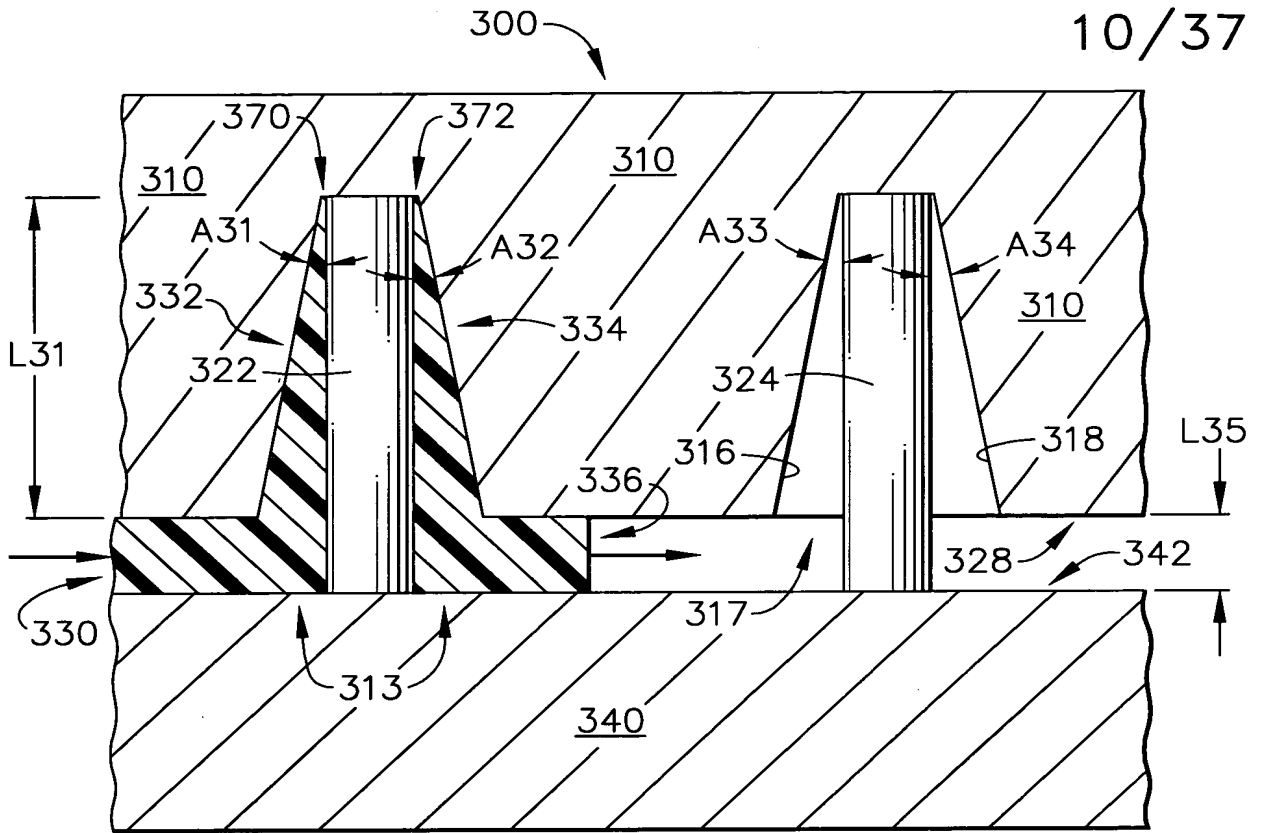


FIG. 16

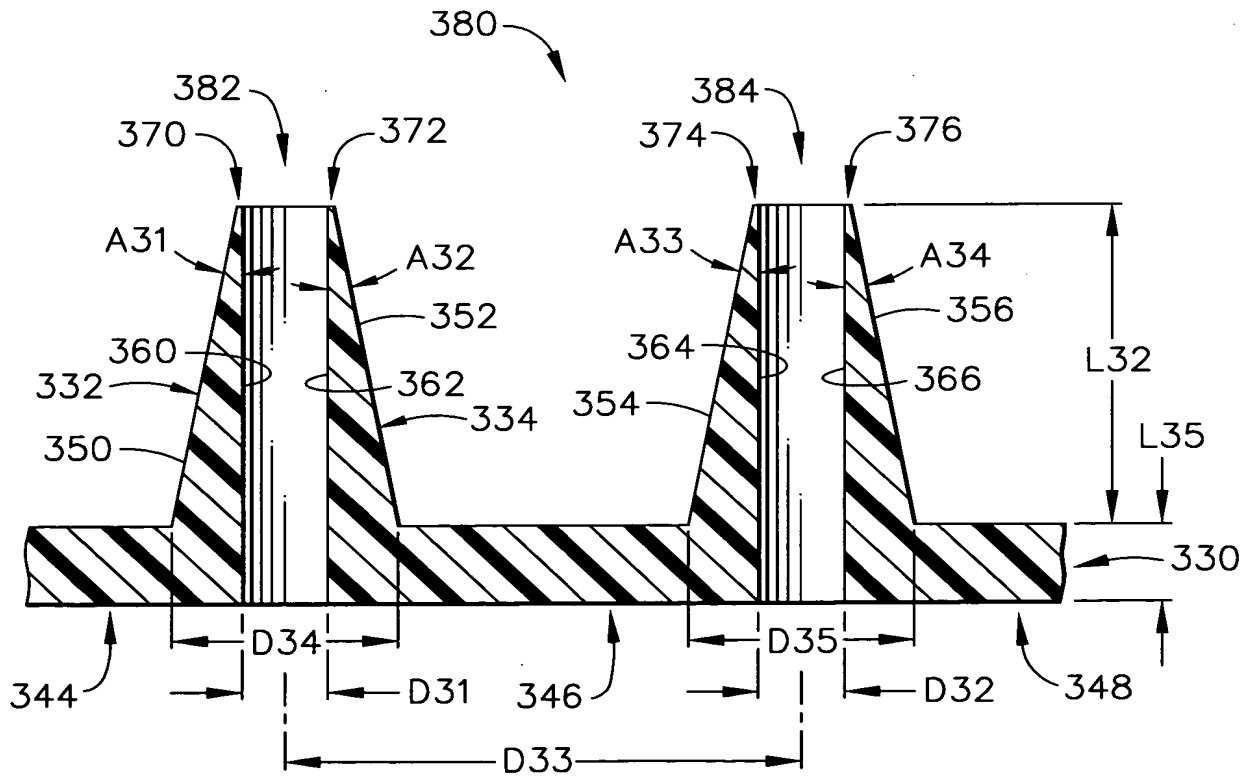


FIG. 17

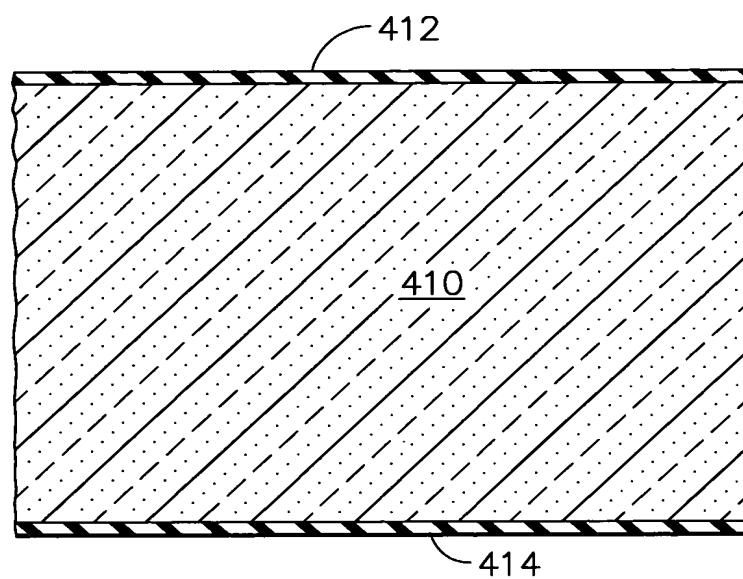


FIG. 18

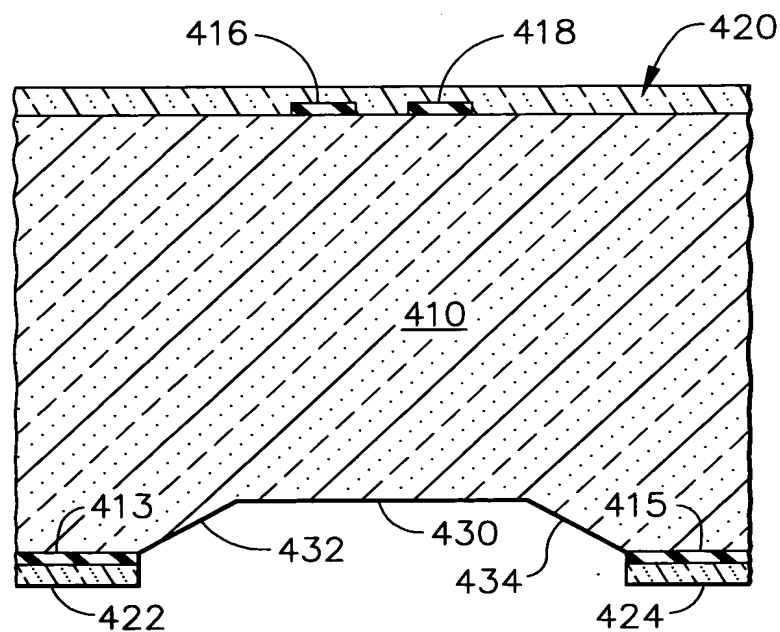


FIG. 19

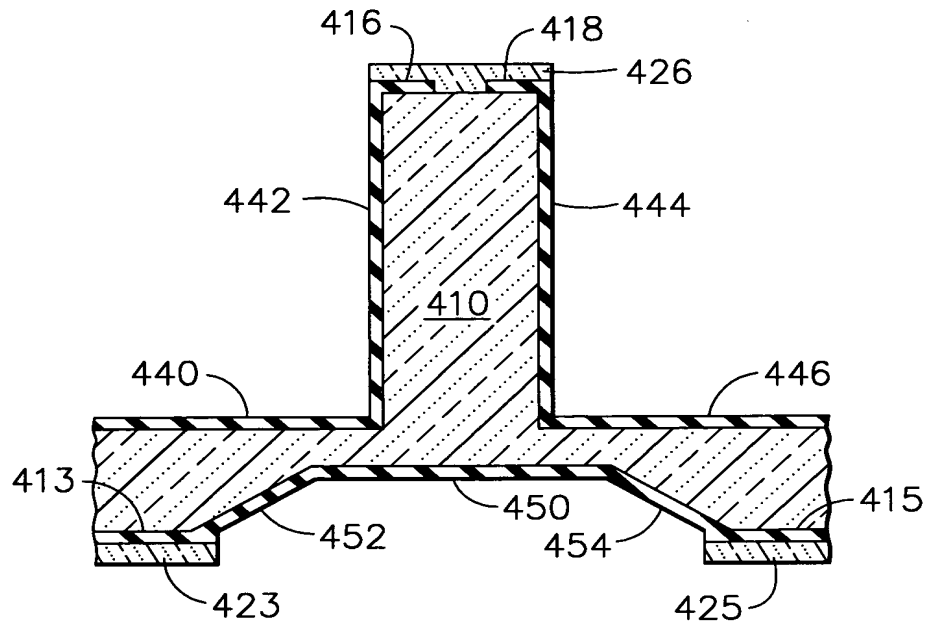


FIG. 20

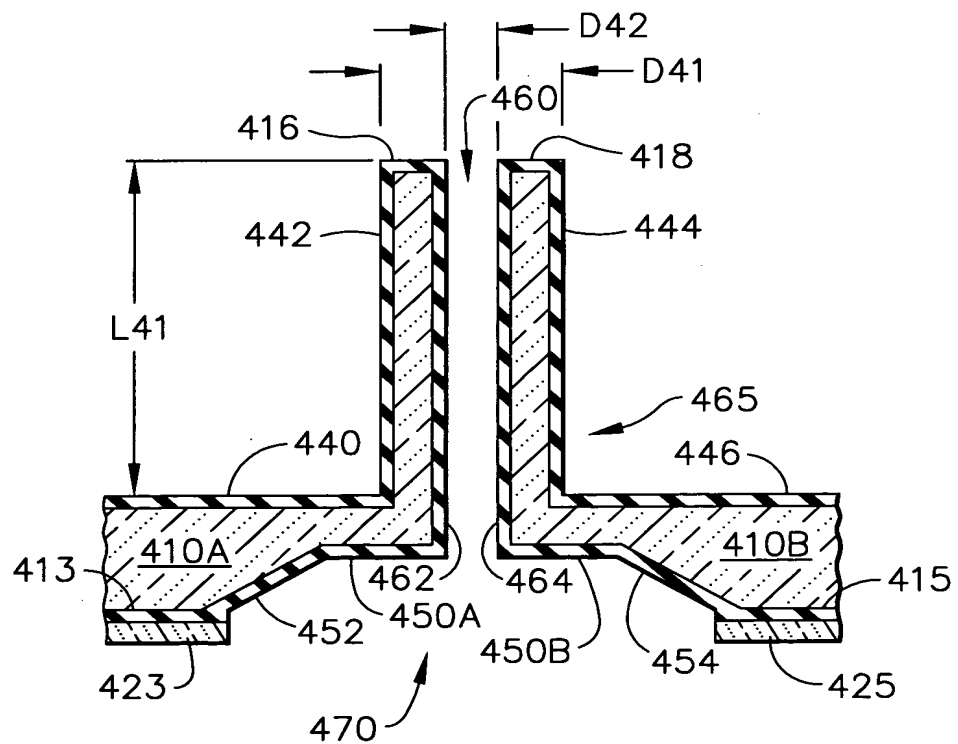


FIG. 21

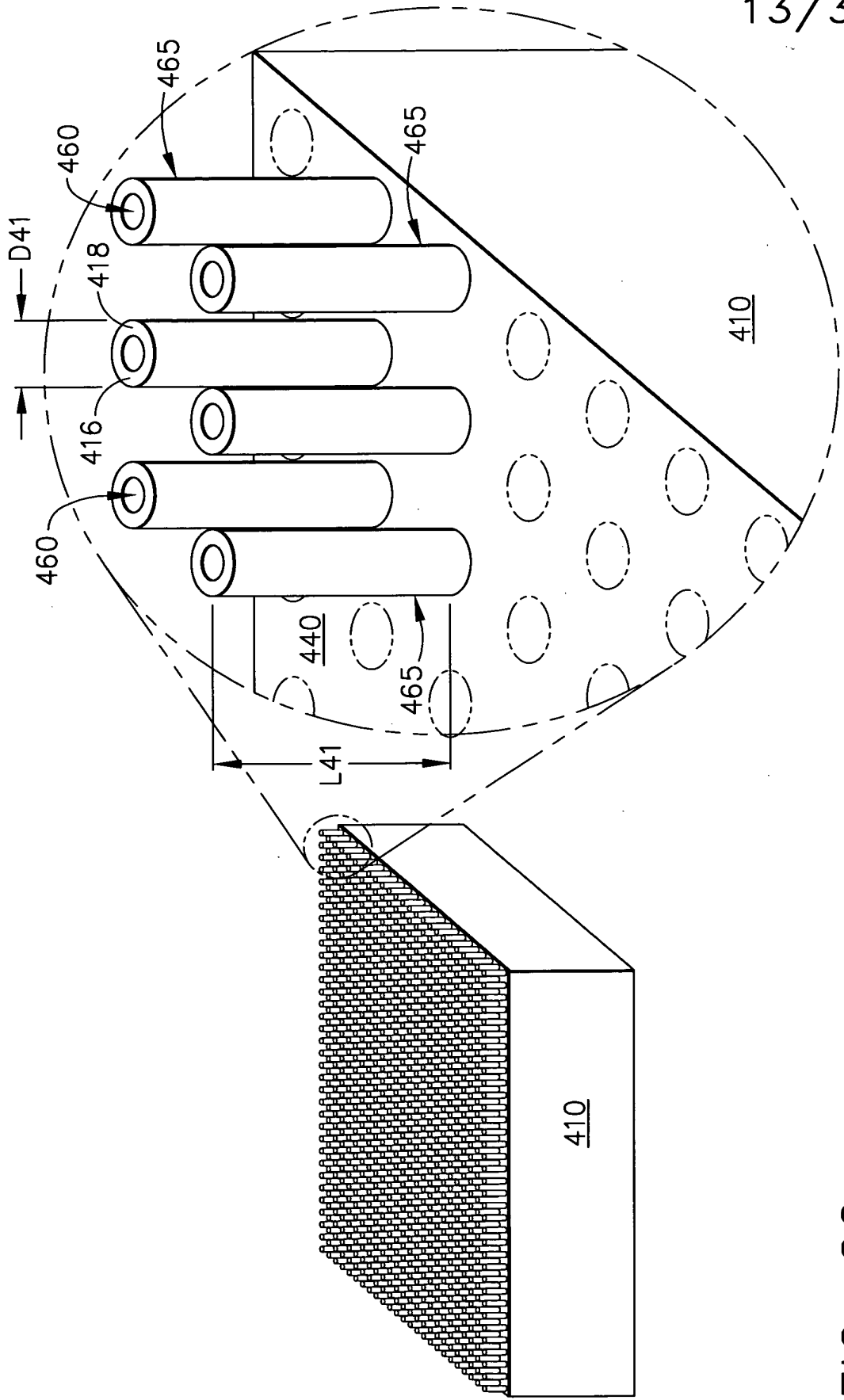


FIG. 22

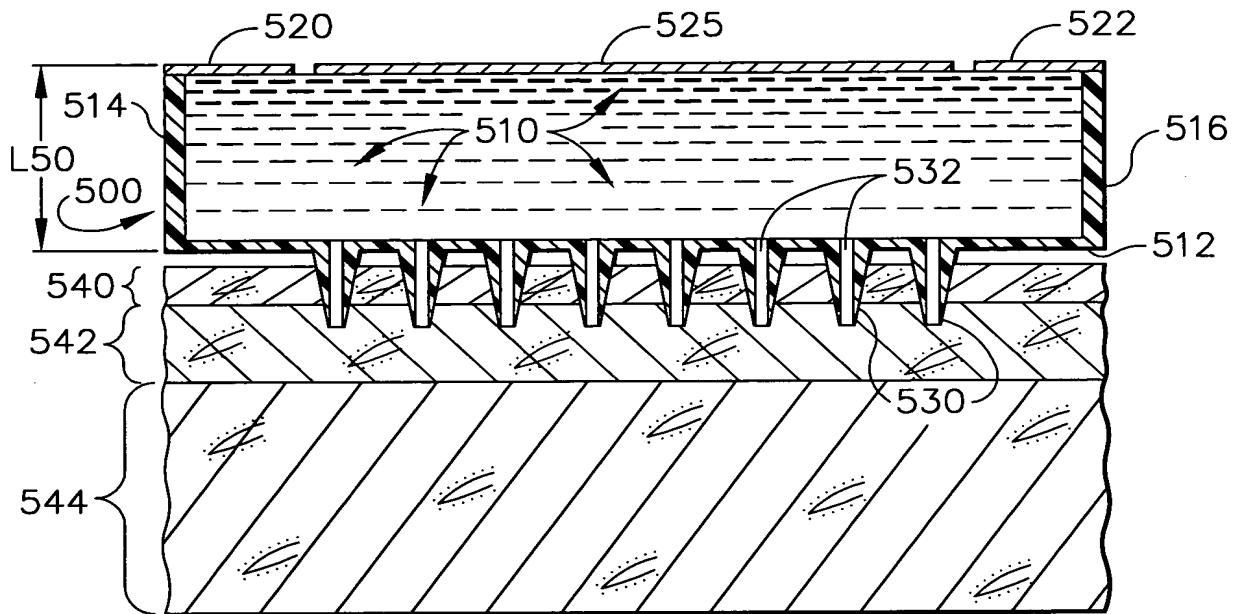


FIG. 23

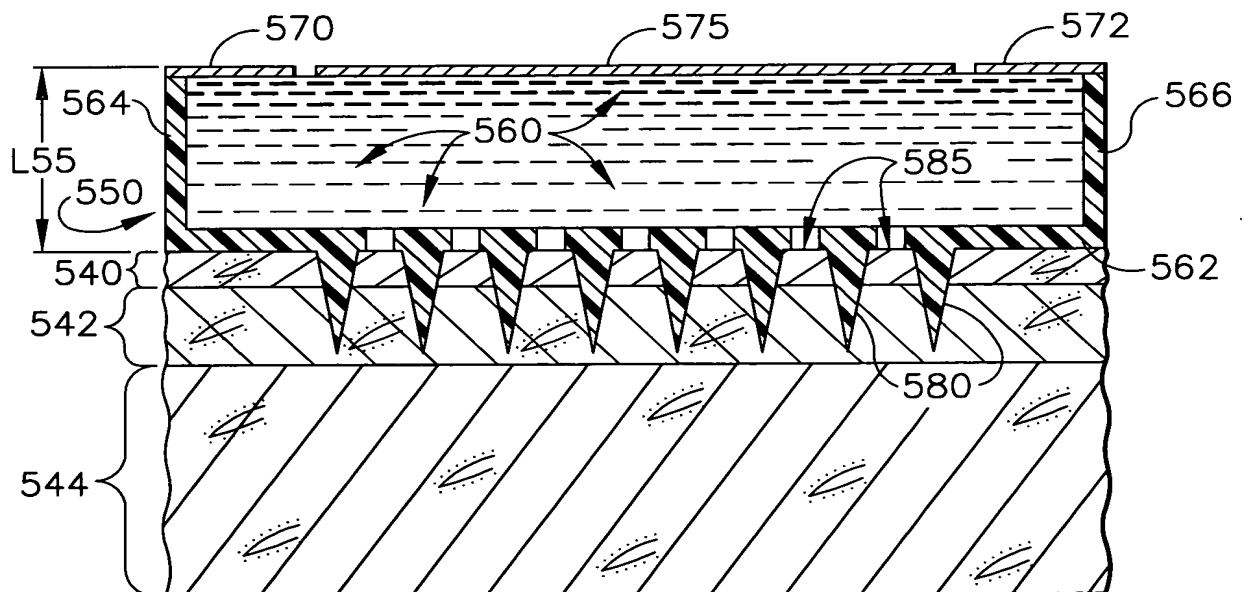


FIG. 24

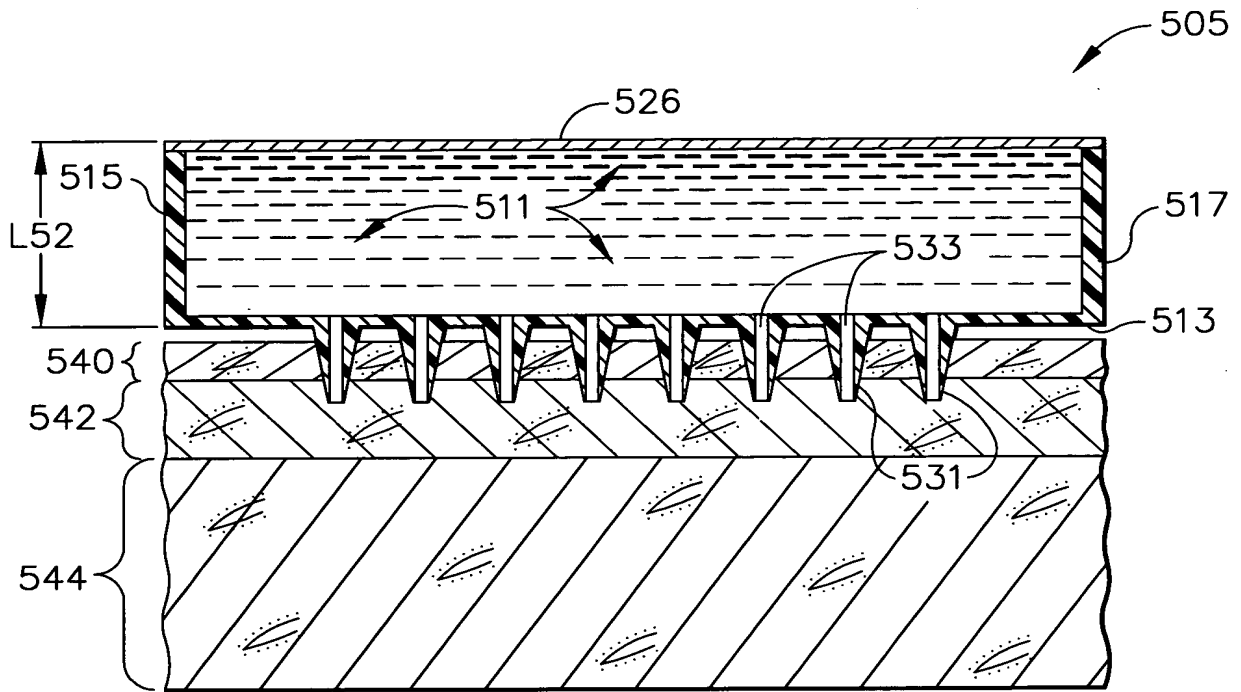


FIG. 25

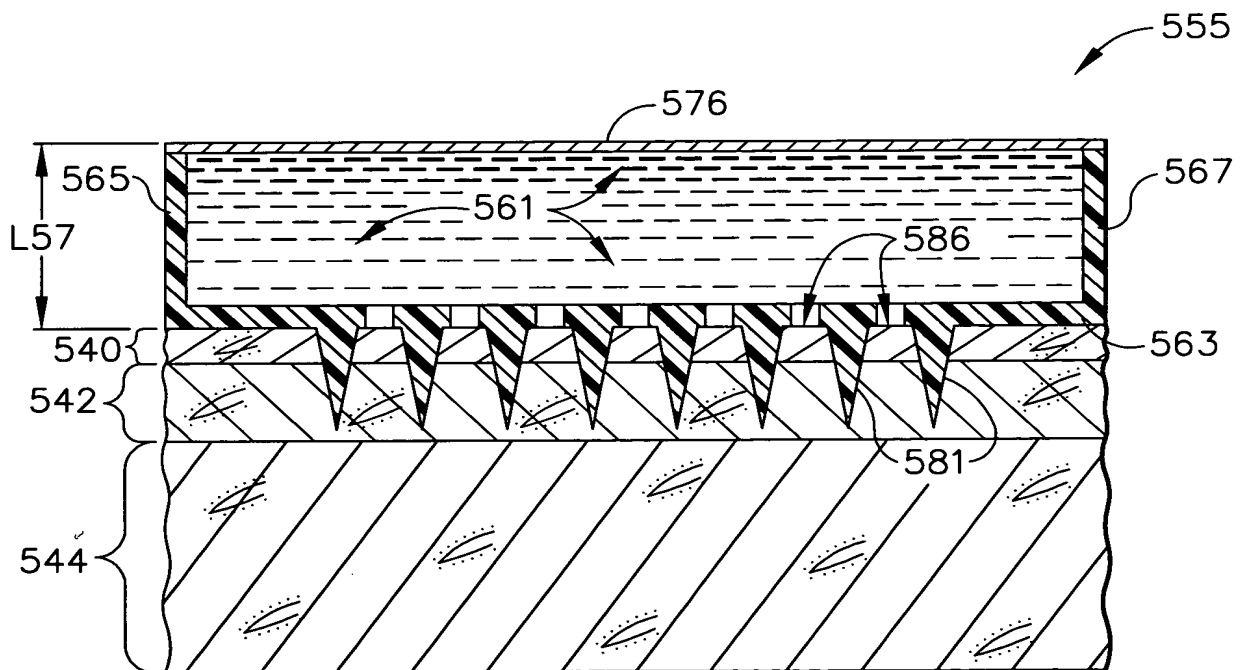


FIG. 26

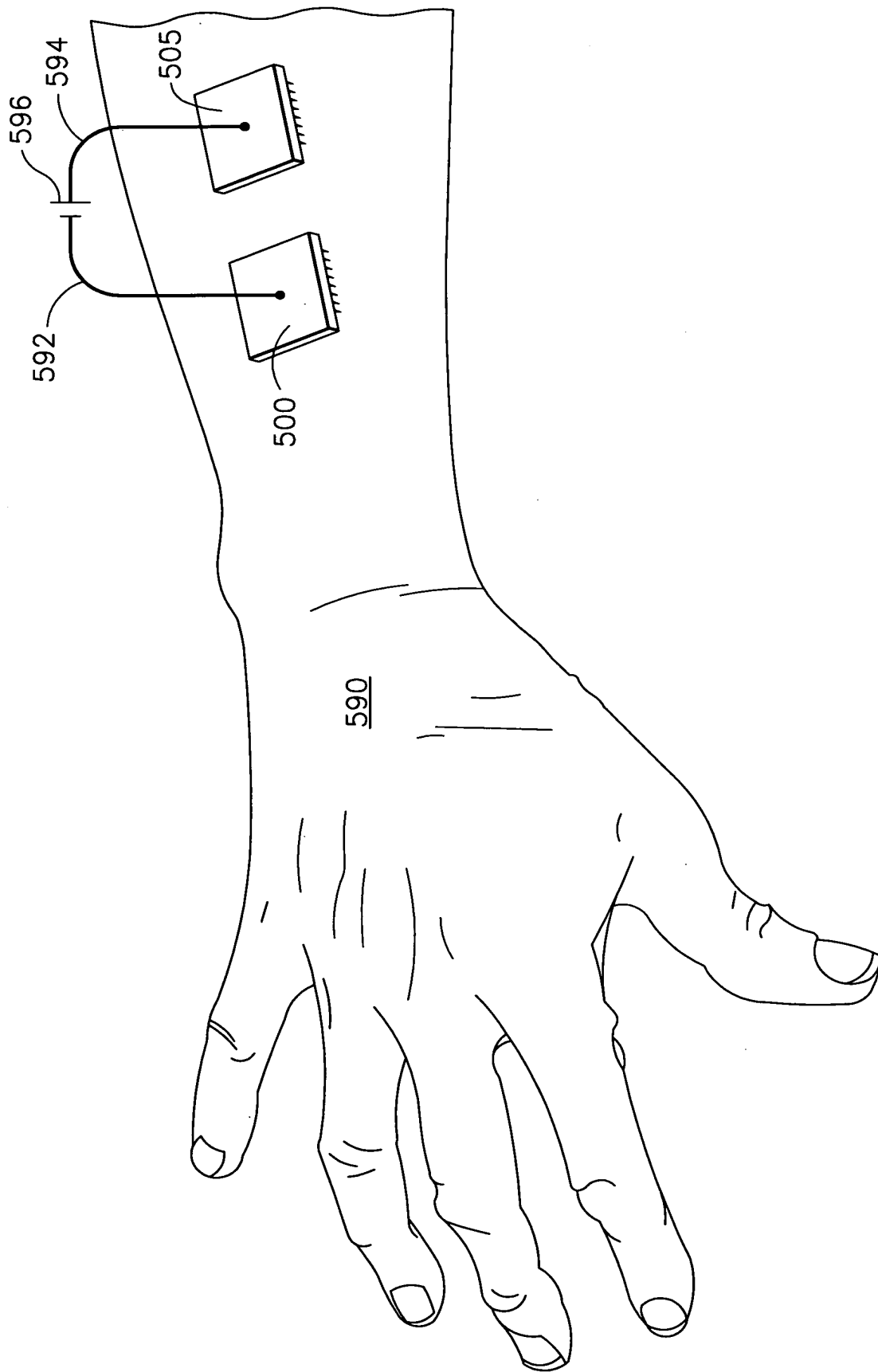


FIG. 27

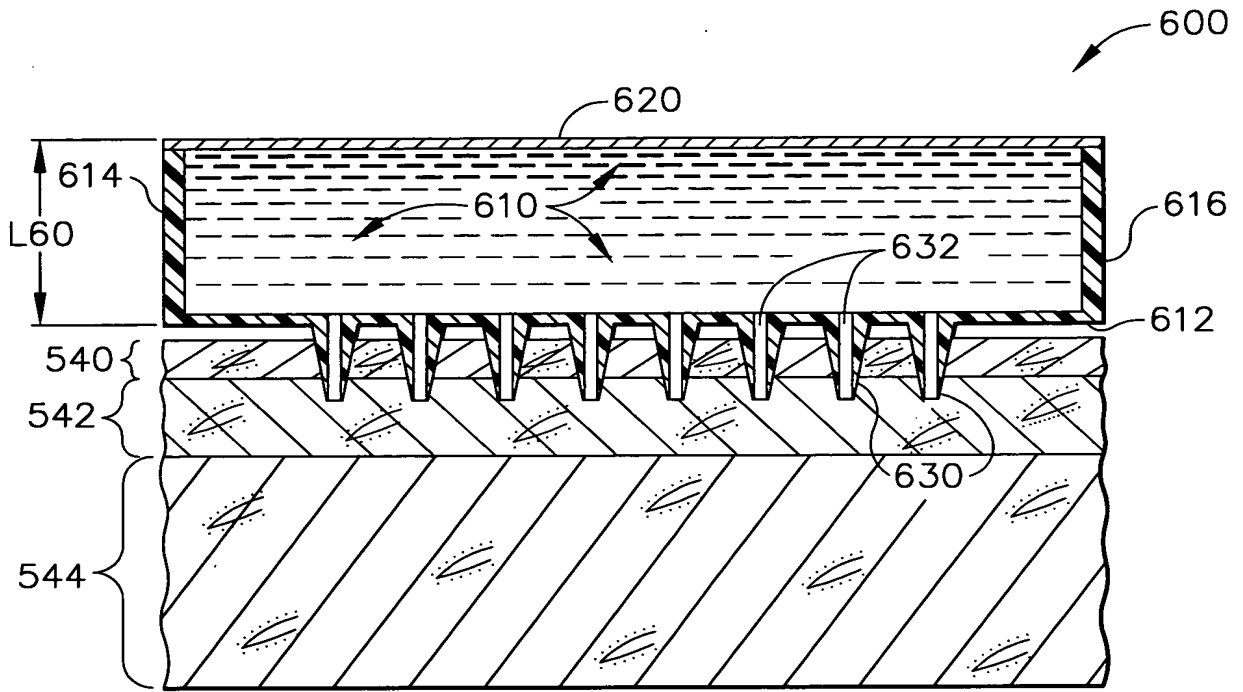


FIG. 28

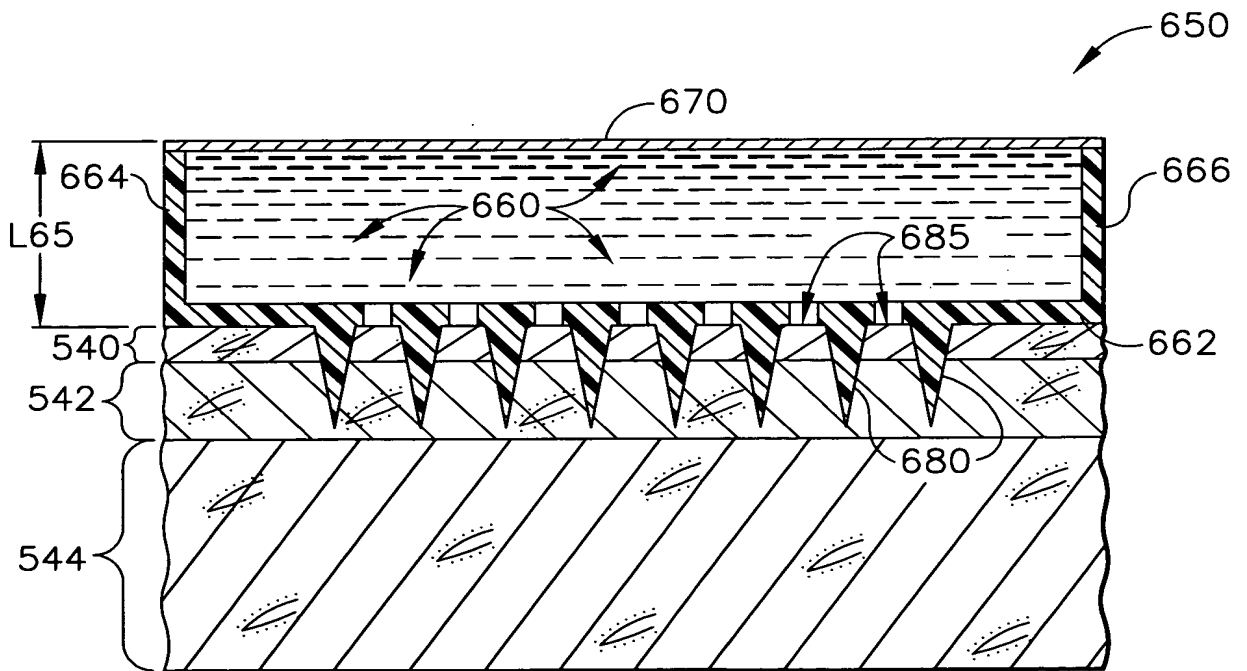


FIG. 29

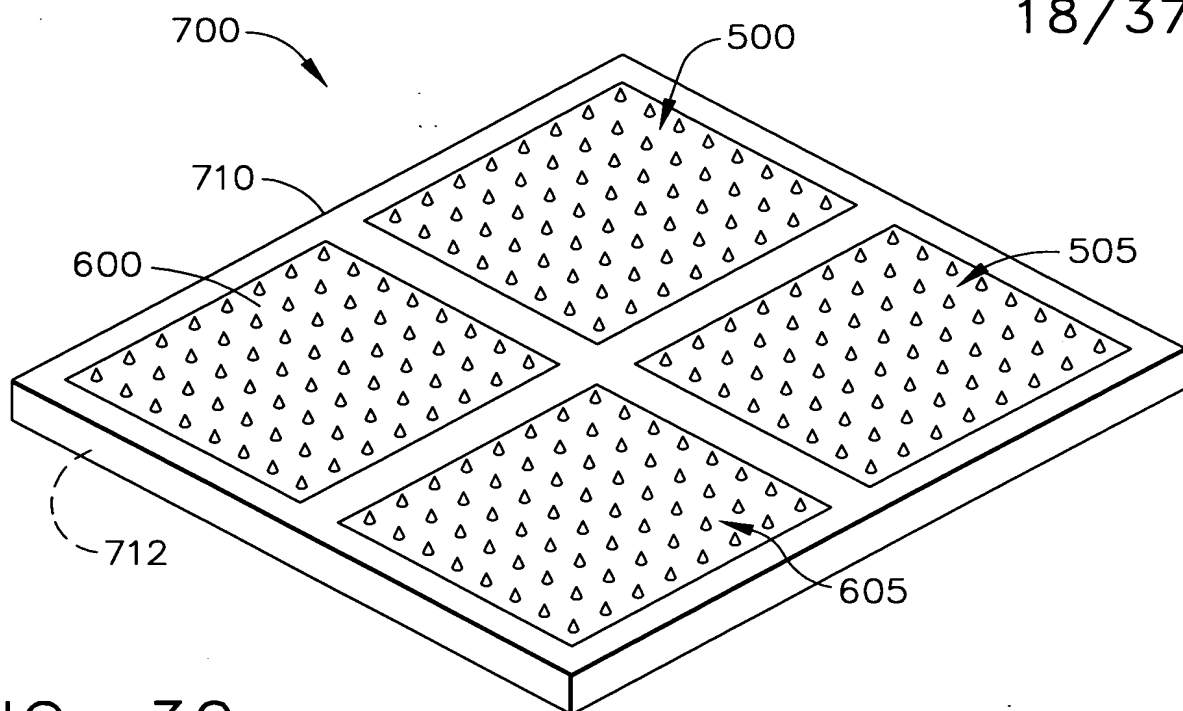


FIG. 30

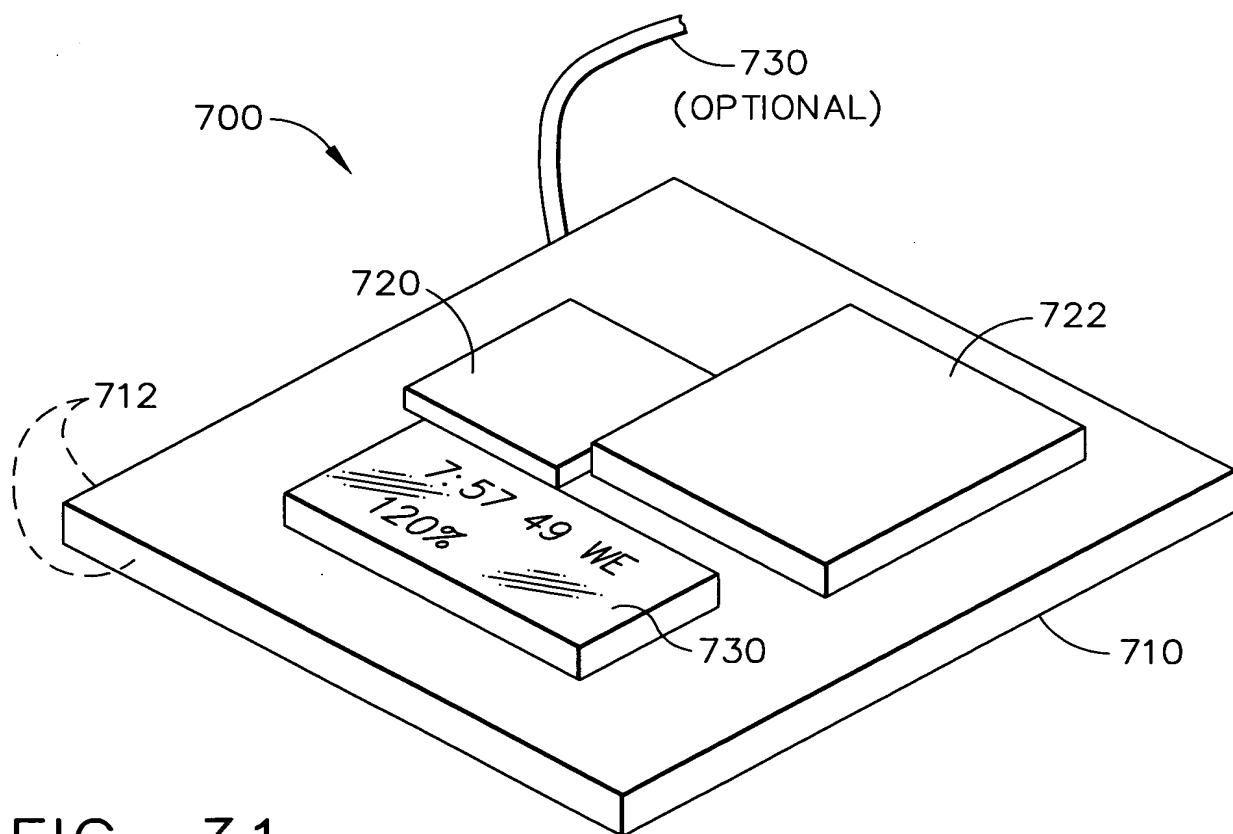


FIG. 31

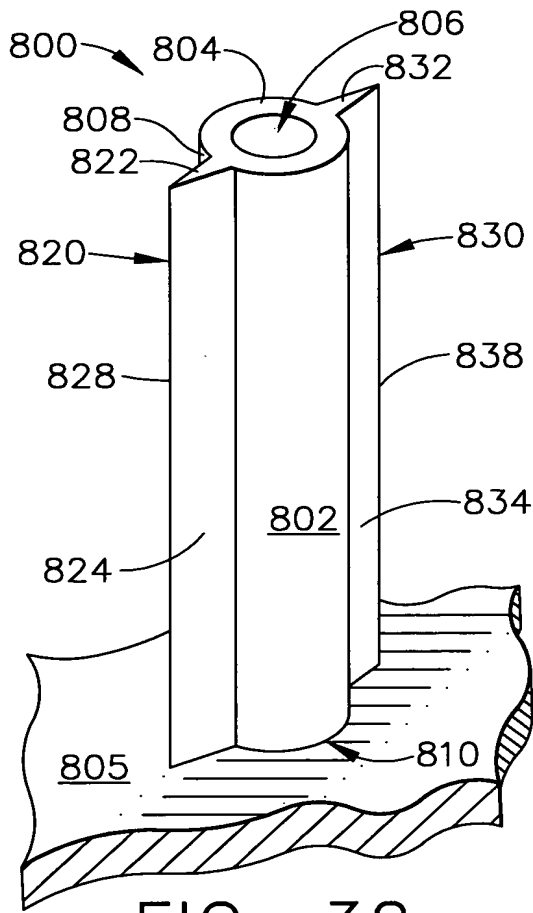


FIG. 32

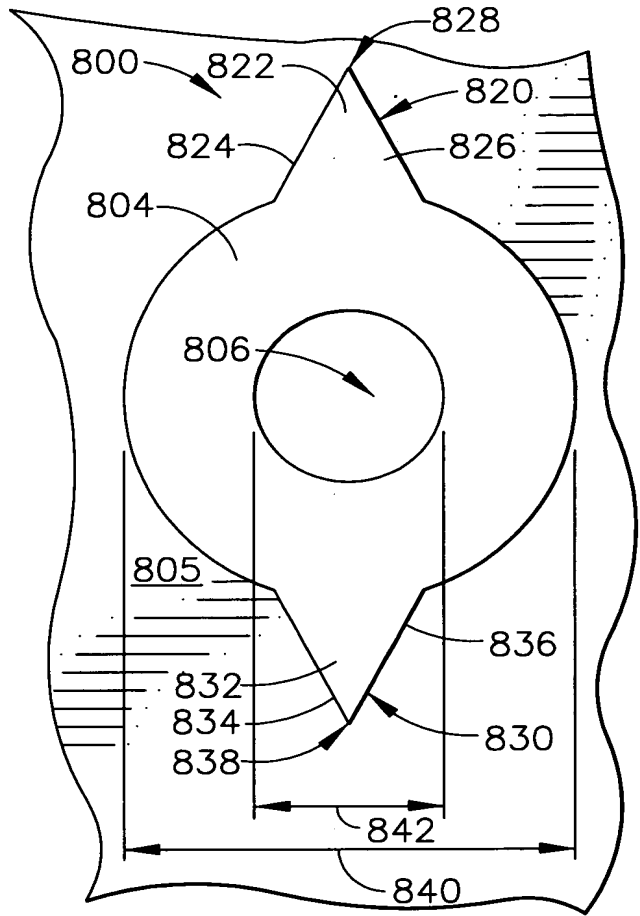


FIG. 33

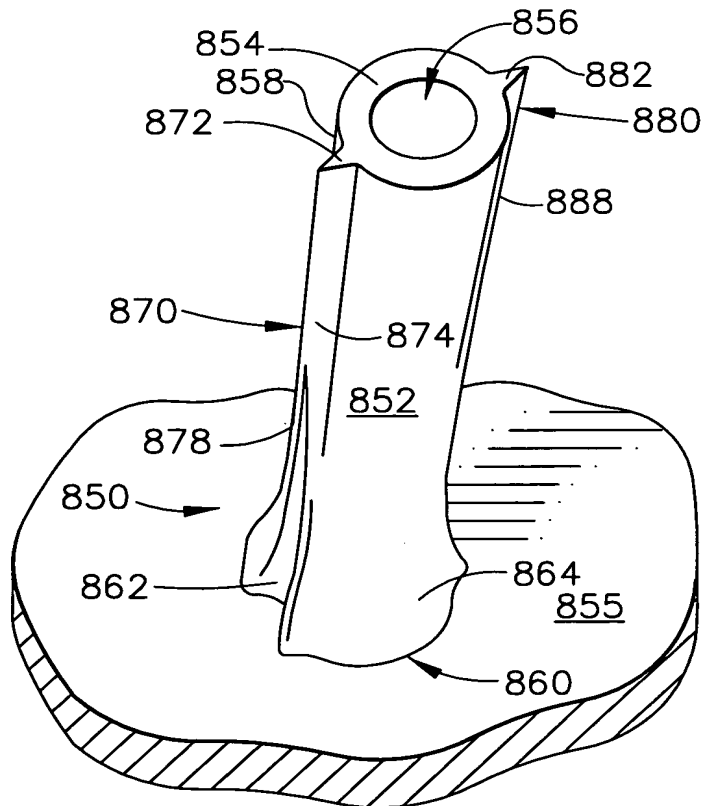


FIG. 34

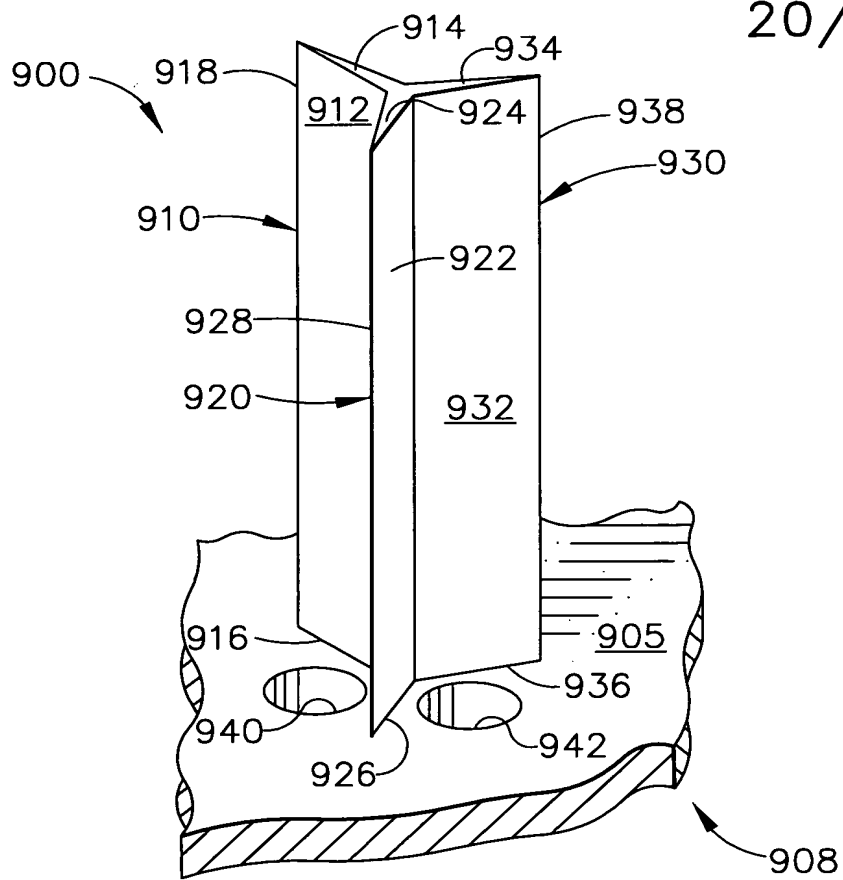


FIG. 35

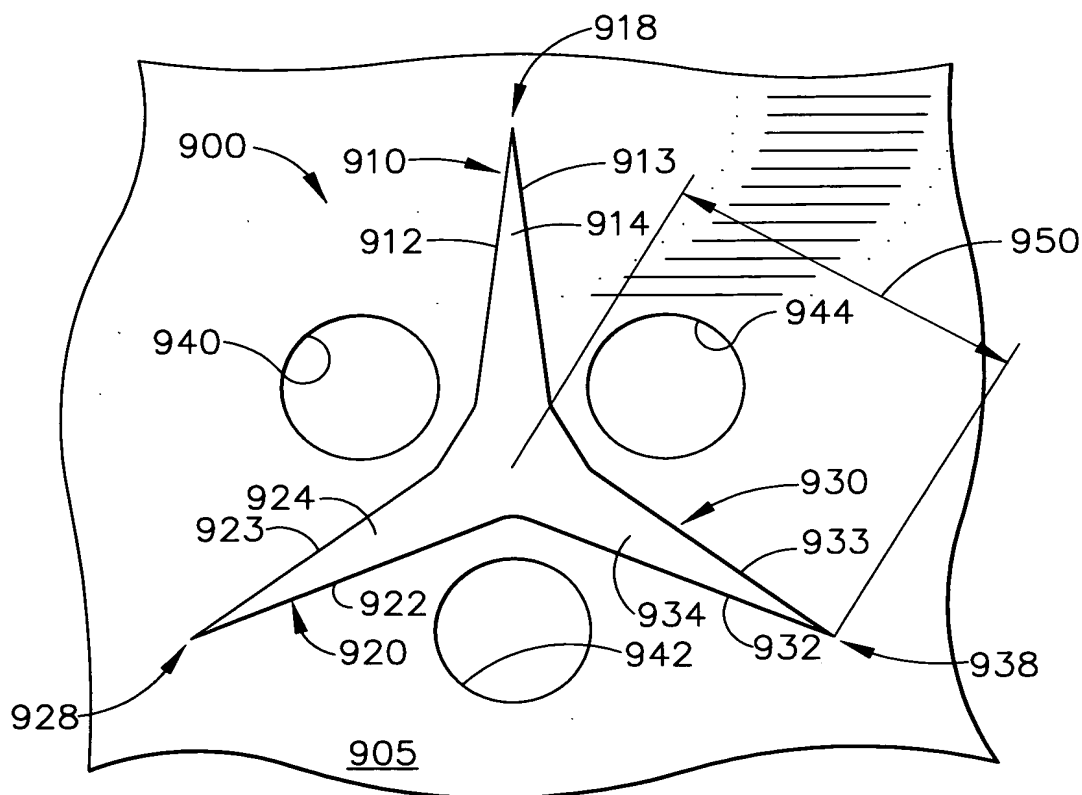






FIG. 36

CIRCULAR μ NEEDLES – SEPARATION = $50\ \mu\text{m}$
OUTER DIAMETER – μm

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







	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90	n	n	n	n	n	n	n	n	n	n
120	n	n	n	n	n	n	n	n	n	n
150	n	n	n	n	n	n	n	n	n	n
180	n	n	n	n	n	n	n	n	n	n
210		n	n	n	n	n	n	n	n	n
240	Y		n	n	n	n	n	n	n	n
270	Y		n	n	n	n	n	n	n	n
300	Y	Y		n	n	n	n	n	n	n

μ NEEDLE LENGTH – μm

1002 –

FIG. 37

CIRCULAR μ NEEDLES – SEPARATION = $100\ \mu\text{m}$
OUTER DIAMETER – μm

	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90		n	n	n	n	n	n	n	n	n
120	Y		n	n	n	n	n	n	n	n
150	Y		n	n	n	n	n	n	n	n
180	Y	Y		n	n	n	n	n	n	n
210	Y	Y	Y		n	n	n	n	n	n
240	Y	Y	Y	Y		n	n	n	n	n
270	Y	Y	Y	Y			n	n	n	n
300	Y	Y	Y	Y	Y	Y		n	n	n












μ NEEDLE LENGTH – μm

1004 –

FIG. 38

CIRCULAR μ NEEDLES - SEPARATION = $150 \mu\text{m}$
OUTER DIAMETER - μm

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










	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90		n	n	n	n	n	n	n	n	n
120	Y		n	n	n	n	n	n	n	n
150	Y			n	n	n	n	n	n	n
180	Y	Y			n	n	n	n	n	n
210	Y	Y	Y	Y		n	n	n	n	n
240	Y	Y	Y	Y	Y		n	n	n	n
270	Y	Y	Y	Y	Y	Y			n	n
300	Y	Y	Y	Y	Y	Y	Y	Y		n

μ NEEDLE LENGTH - μm

FIG. 39

1006

CIRCULAR μ NEEDLES - SEPARATION = $200 \mu\text{m}$
OUTER DIAMETER - μm

	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60		n	n	n	n	n	n	n	n	n
90	Y		n	n	n	n	n	n	n	n
120	Y	Y		n	n	n	n	n	n	n
150	Y	Y	Y		n	n	n	n	n	n
180	Y	Y	Y	Y			n	n	n	n
210	Y	Y	Y	Y	Y	Y			n	n
240	Y	Y	Y	Y	Y	Y	Y			n
270	Y	Y	Y	Y	Y	Y	Y	Y		
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y













μ NEEDLE LENGTH - μm

FIG. 40

1008

CIRCULAR μ NEEDLES - SEPARATION = $250 \mu\text{m}$
OUTER DIAMETER - μm











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	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90			n	n	n	n	n	n	n	n
120	Y	Y		n	n	n	n	n	n	n
150	Y	Y	Y						n	n
180	Y	Y	Y	Y	Y	Y	Y			n
210	Y	Y	Y	Y	Y	Y	Y	Y		
240	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
270	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

μ NEEDLE LENGTH - μm

FIG. 41

CIRCULAR μ NEEDLES - SEPARATION = $300 \mu\text{m}$
OUTER DIAMETER - μm




	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90		n	n	n	n	n	n	n	n	n
120	Y				n	n	n	n	n	n
150	Y	Y	Y	Y				n	n	n
180	Y	Y	Y	Y	Y	Y	Y			
210	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
240	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
270	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

μ NEEDLE LENGTH - μm

FIG. 42

EDGED μ NEEDLES - SEPARATION = 50 μ m
OUTER DIAMETER - μ m

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	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90	n	n	n	n	n	n	n	n	n	n
120	n	n	n	n	n	n	n	n	n	n
150		n	n	n	n	n	n	n	n	n
180	Y	n	n	n	n	n	n	n	n	n
210	Y	n	n	n	n	n	n	n	n	n
240	Y		n	n	n	n	n	n	n	n
270	Y	Y	n	n	n	n	n	n	n	n
300	Y	Y		n	n	n	n	n	n	n

μ NEEDLE LENGTH - μ m

1022-

FIG. 43

EDGED μ NEEDLES - SEPARATION = 100 μ m
OUTER DIAMETER - μ m

	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60		n	n	n	n	n	n	n	n	n
90	Y		n	n	n	n	n	n	n	n
120	Y	Y		n	n	n	n	n	n	n
150	Y	Y	Y	n	n	n	n	n	n	n
180	Y	Y	Y	n	n	n	n	n	n	n
210	Y	Y	Y		n	n	n	n	n	n
240	Y	Y	Y	Y		n	n	n	n	n
270	Y	Y	Y	Y	Y		n	n	n	n
300	Y	Y	Y	Y	Y	Y	n	n	n	n











μ NEEDLE LENGTH - μ m

1024-

FIG. 44

EDGED μ NEEDLES - SEPARATION = 150 μ m
OUTER DIAMETER - μ m

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


	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60			n	n	n	n	n	n	n	n
90	Y	Y		n	n	n	n	n	n	n
120	Y	Y	Y		n	n	n	n	n	n
150	Y	Y	Y	Y		n	n	n	n	n
180	Y	Y	Y	Y	Y		n	n	n	n
210	Y	Y	Y	Y	Y	Y		n	n	n
240	Y	Y	Y	Y	Y	Y	Y		n	n
270	Y	Y	Y	Y	Y	Y	Y	Y		n
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	

μ NEEDLE LENGTH - μ m

-1026

FIG. 45

EDGED μ NEEDLES - SEPARATION = 200 μ m
OUTER DIAMETER - μ m

	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60	n	n	n	n	n	n	n	n	n	n
90			n	n	n	n	n	n	n	n
120	Y	Y		n	n	n	n	n	n	n
150	Y	Y	Y				n	n	n	n
180	Y	Y	Y	Y	Y	Y		n	n	n
210	Y	Y	Y	Y	Y	Y	Y			n
240	Y	Y	Y	Y	Y	Y	Y	Y	Y	
270	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y











μ NEEDLE LENGTH - μ m

-1028

FIG. 46

EDGED μ NEEDLES - SEPARATION = 250 μ m
OUTER DIAMETER - μ m











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	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60		n	n	n	n	n	n	n	n	n
90	Y			n	n	n	n	n	n	n
120	Y	Y	Y				n	n	n	n
150	Y	Y	Y	Y	Y	Y				
180	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
210	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
240	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
270	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

μ NEEDLE LENGTH - μ m
-1030

FIG. 47

EDGED μ NEEDLES - SEPARATION = 300 μ m
OUTER DIAMETER - μ m

	10	20	30	40	50	60	70	80	90	100
30	n	n	n	n	n	n	n	n	n	n
60		n	n	n	n	n	n	n	n	n
90	Y				n	n	n	n	n	n
120	Y	Y	Y	Y				n	n	n
150	Y	Y	Y	Y	Y	Y	Y		n	n
180	Y	Y	Y	Y	Y	Y	Y	Y		
210	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
240	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
270	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
300	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

μ NEEDLE LENGTH - μ m
-1032

FIG. 48

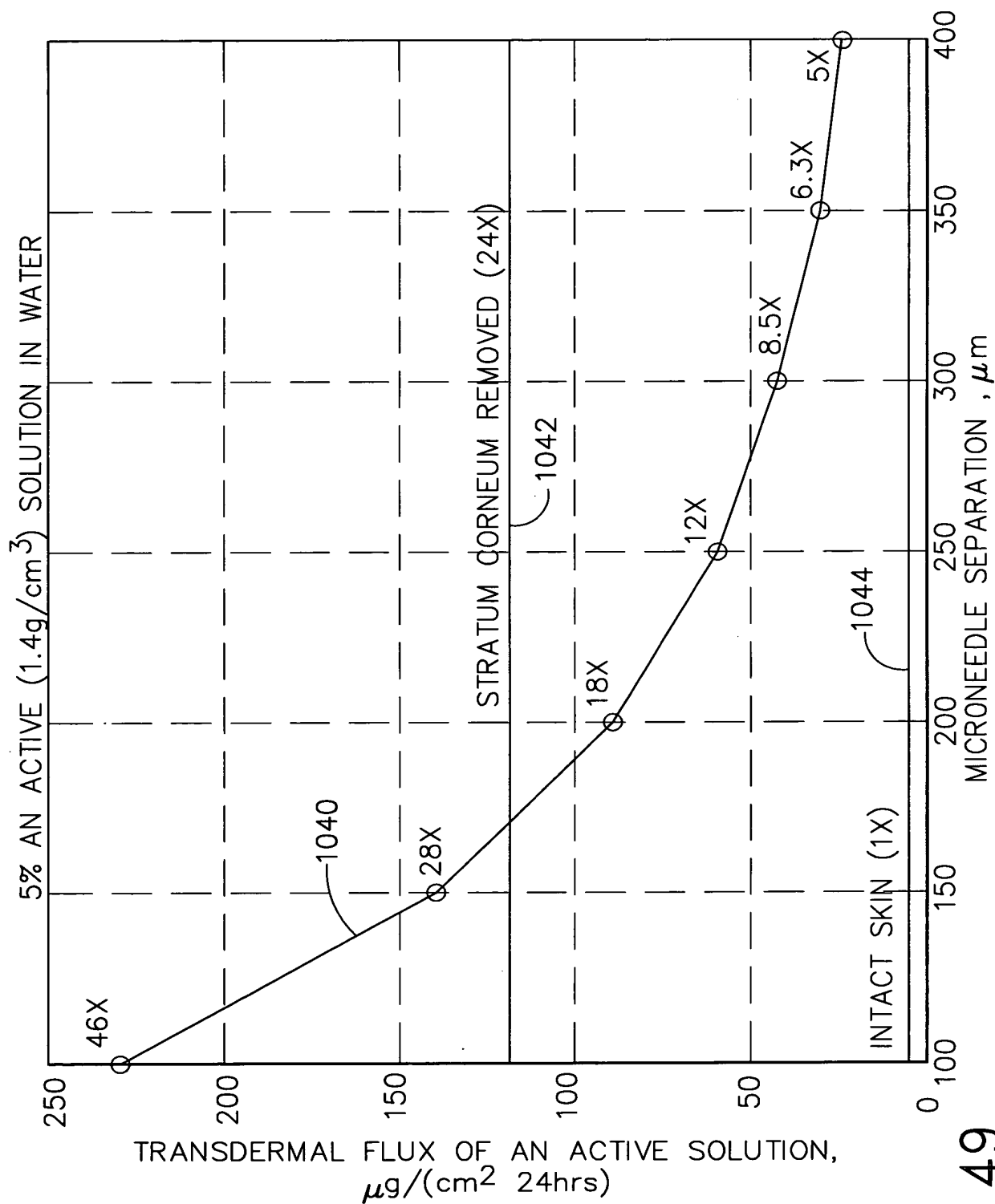


FIG. 49

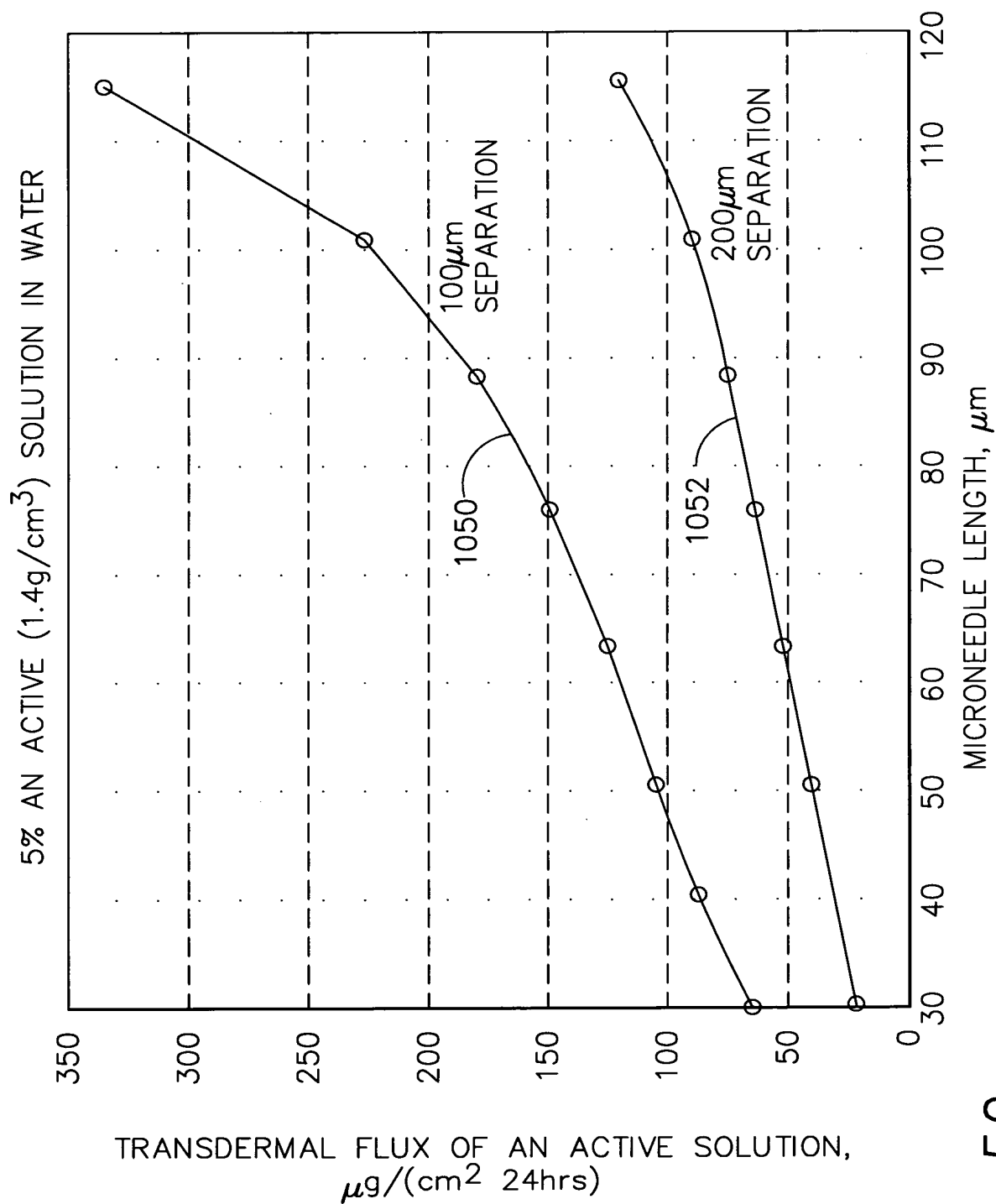


FIG. 50

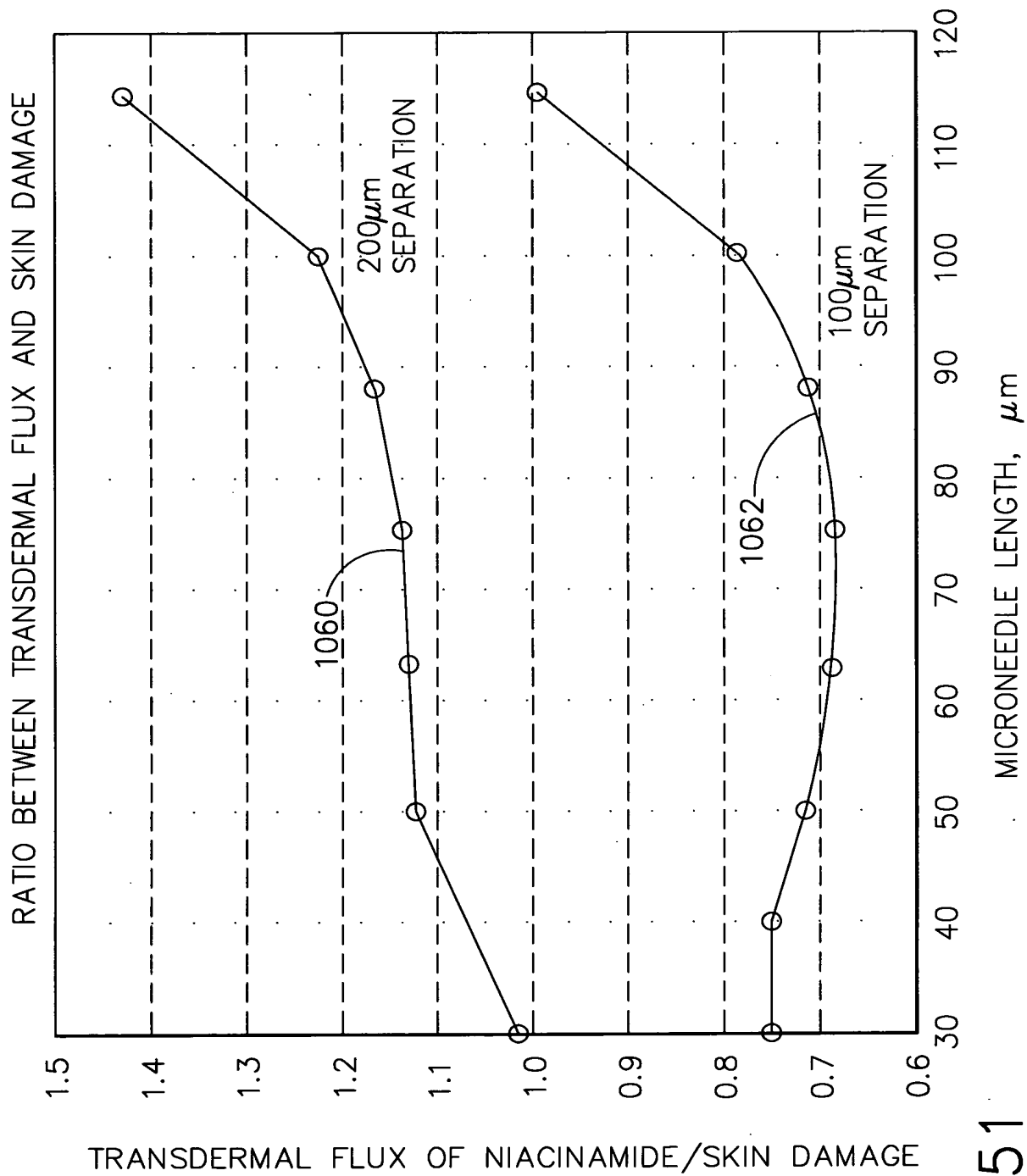


FIG. 51

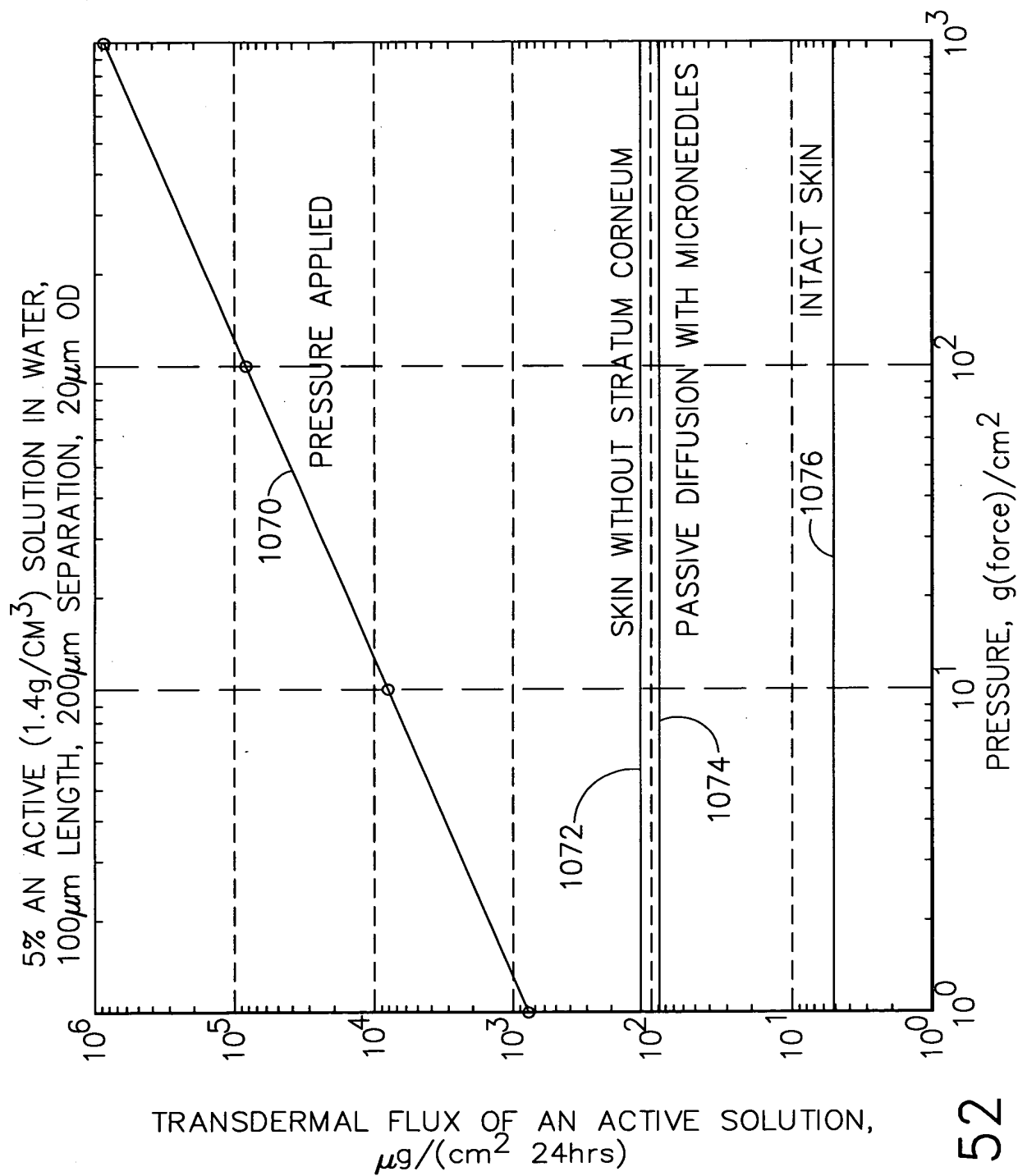
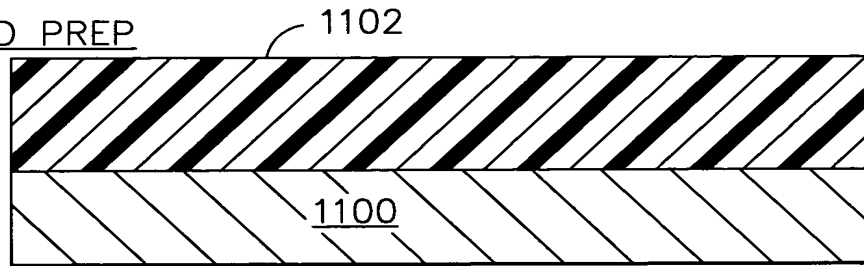


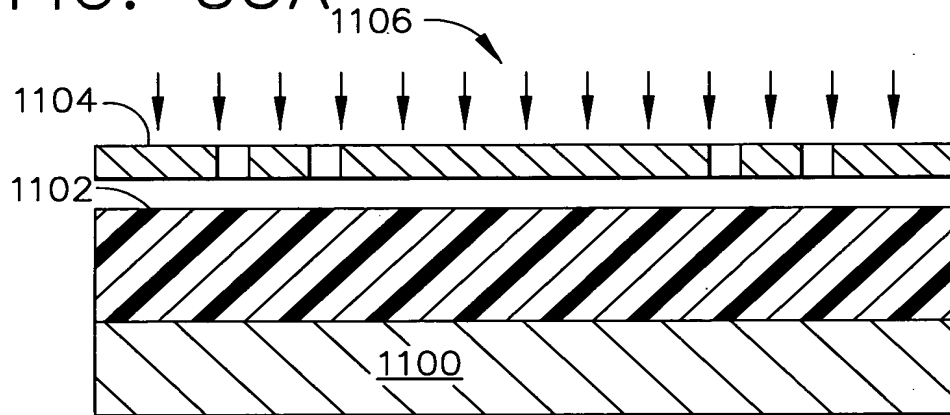
FIG. 52

MOLD PREP



PMMA

FIG. 53A

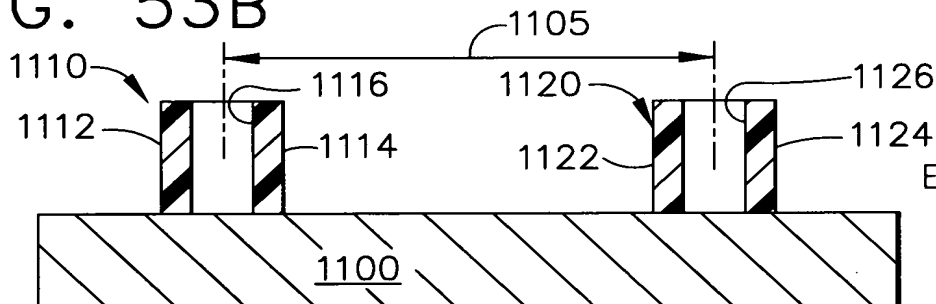


X-RAY

MASK

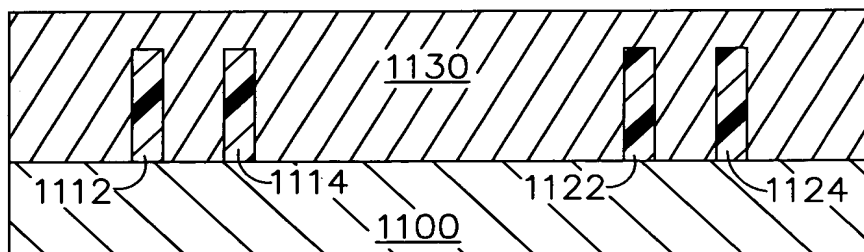
PMMA

FIG. 53B



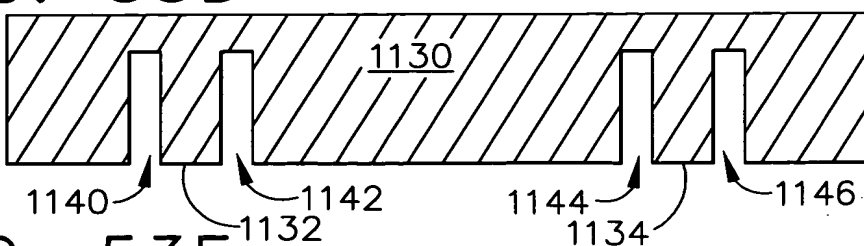
EXPOSE AND
DEVELOPE

FIG. 53C



ELECTROPLATE
WITH METAL

FIG. 53D



DETACH
METAL
MOLD

FIG. 53E

EMBOSSING

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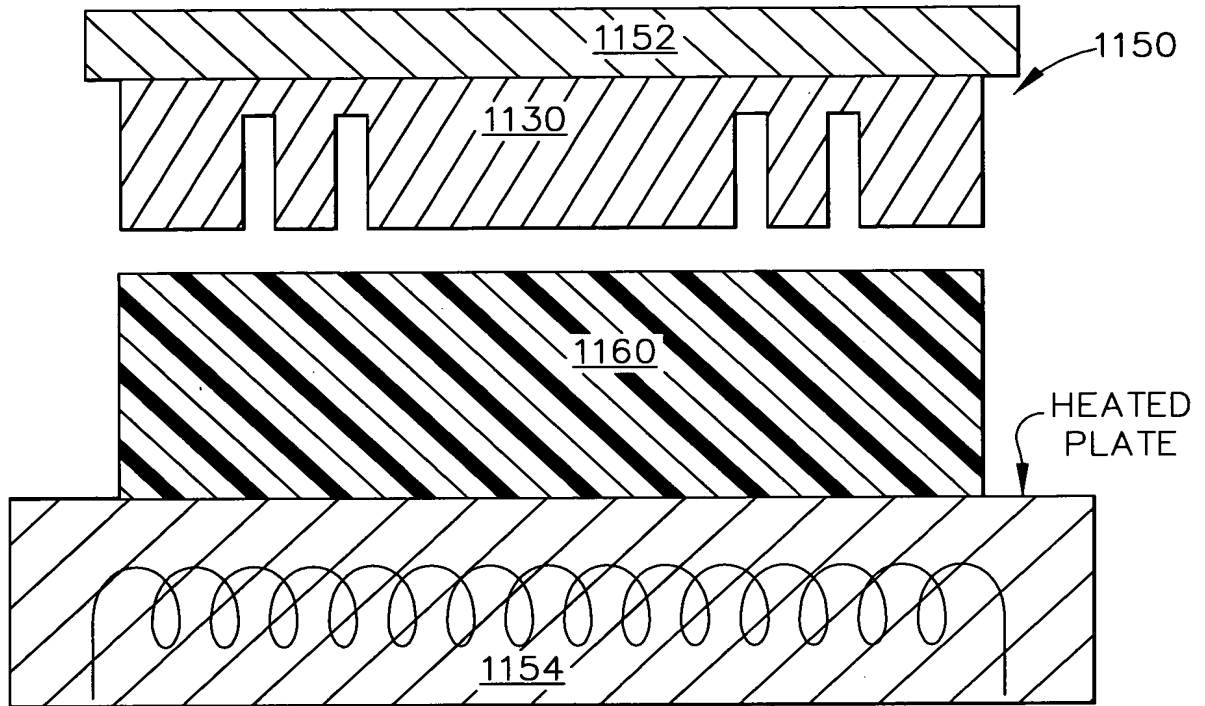


FIG. 54A

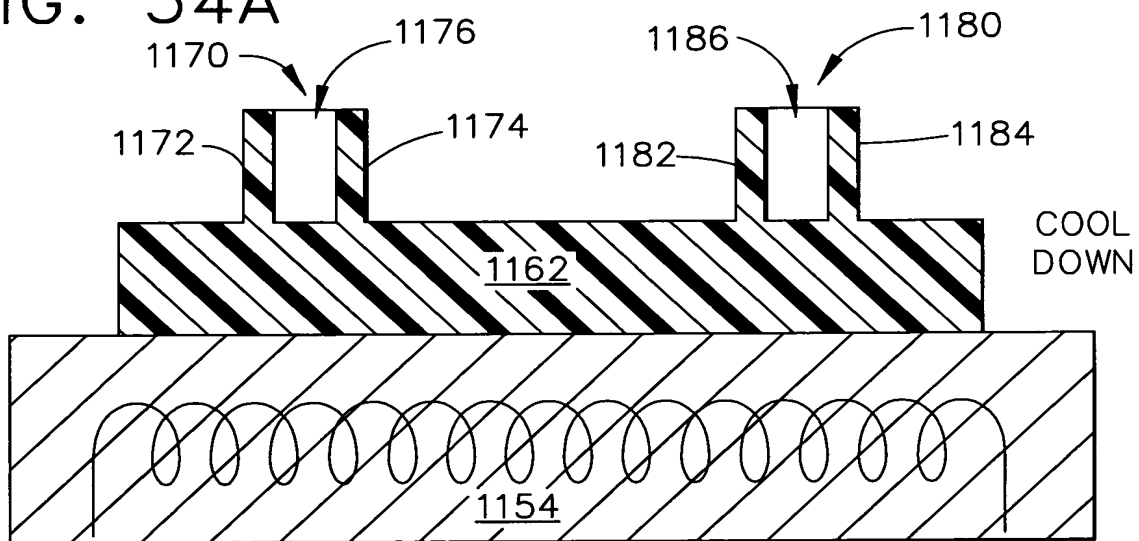


FIG. 54B

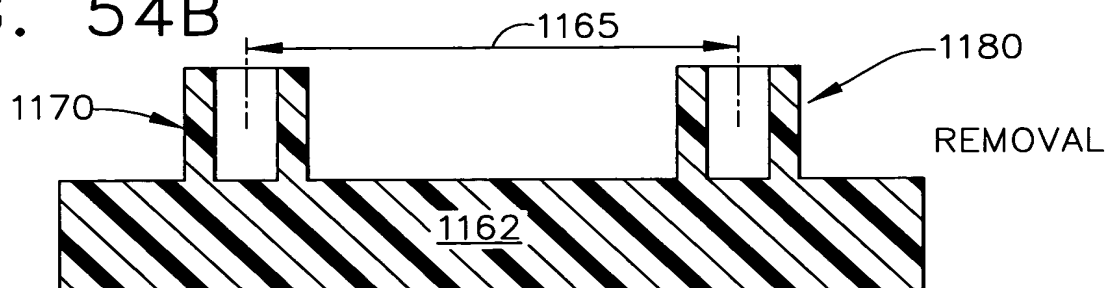


FIG. 54C

009250" 6T808560

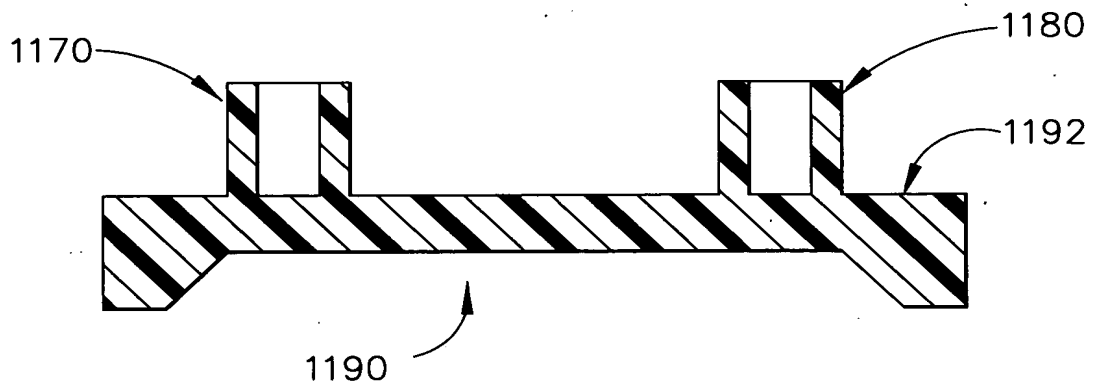


FIG. 54D

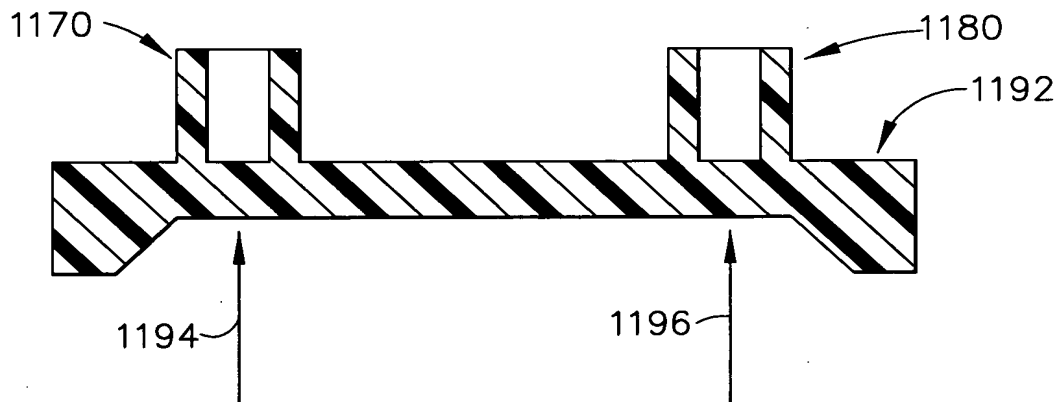


FIG. 54E

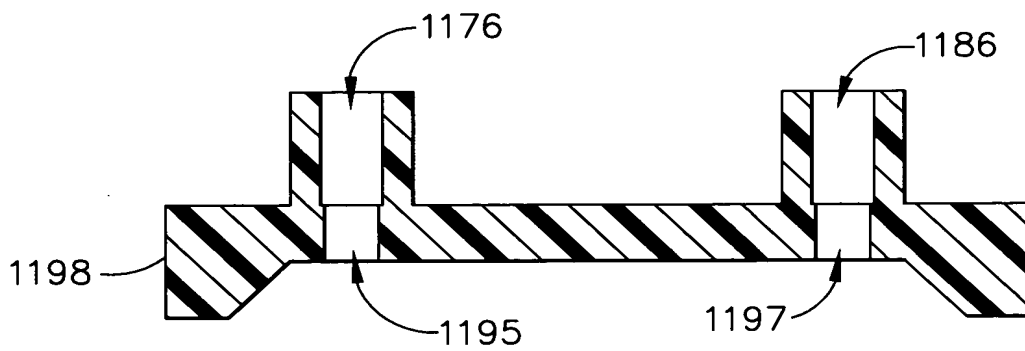


FIG. 54F

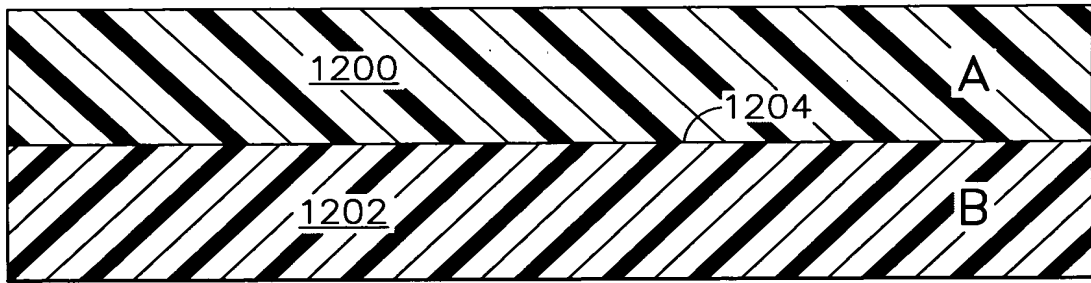


FIG. 55A

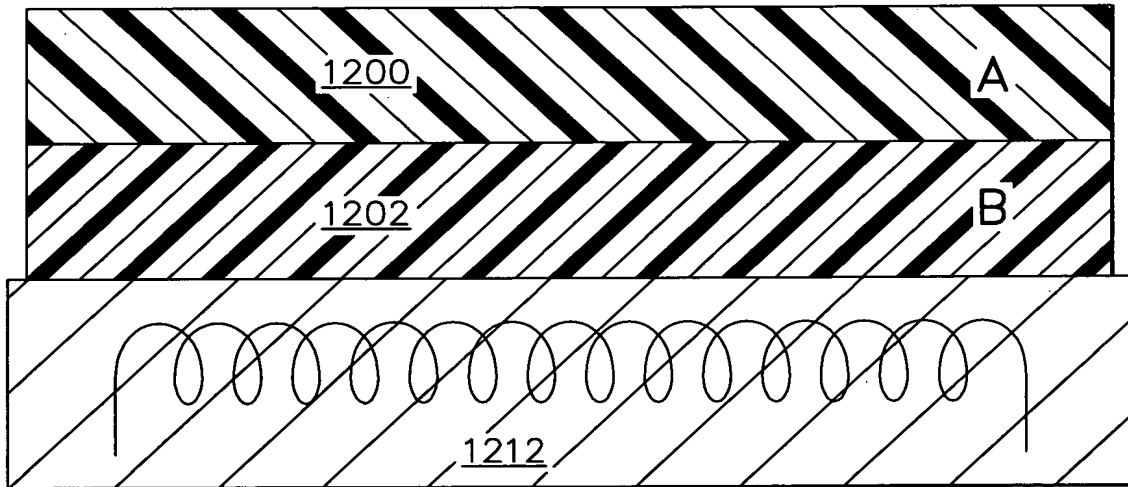
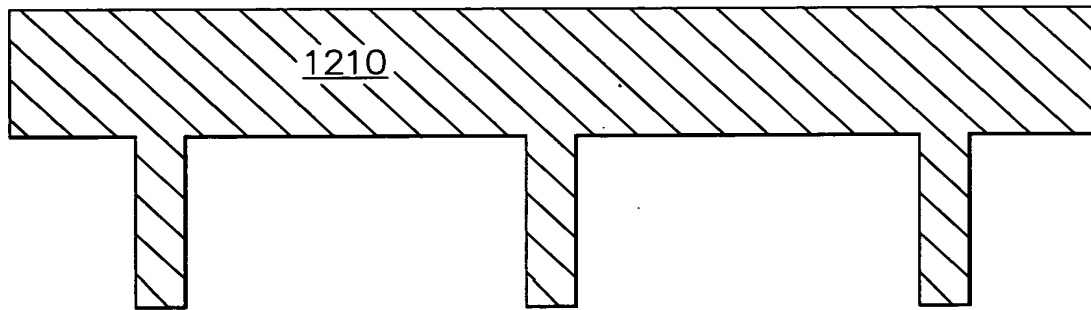


FIG. 55B

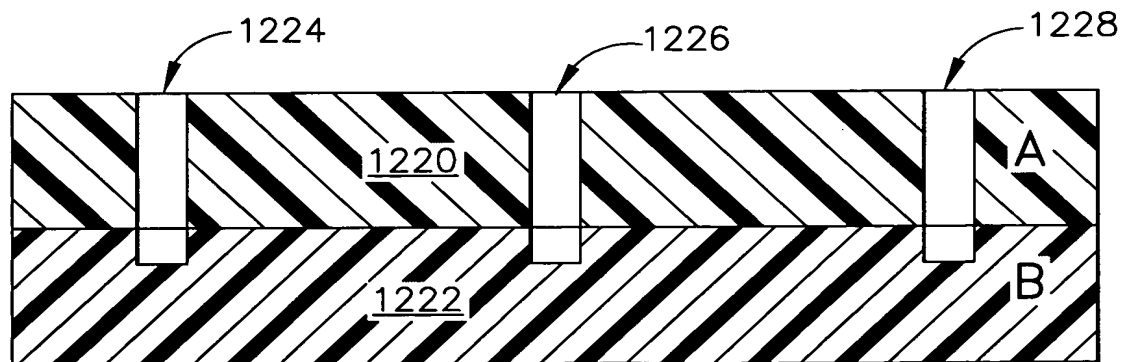


FIG. 55C

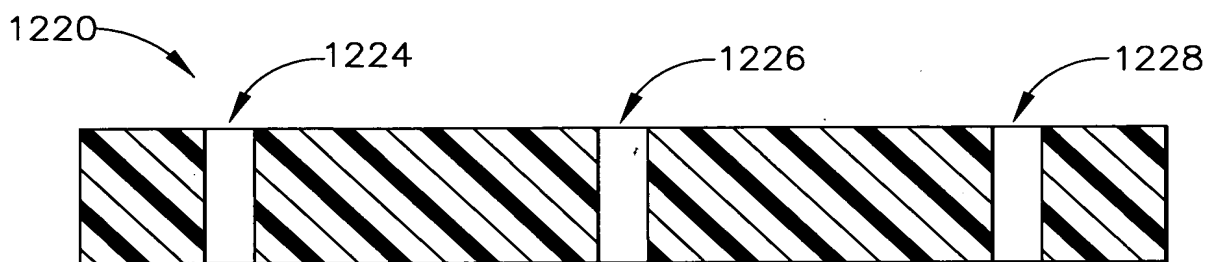


FIG. 55D

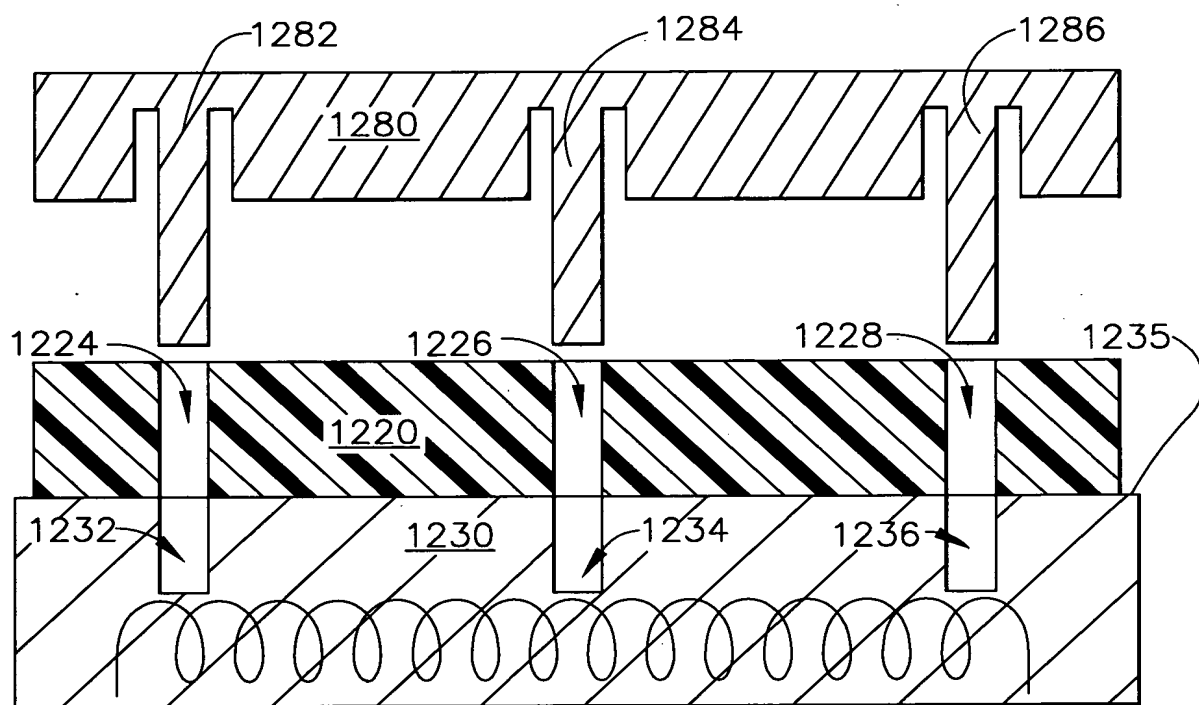


FIG. 55E

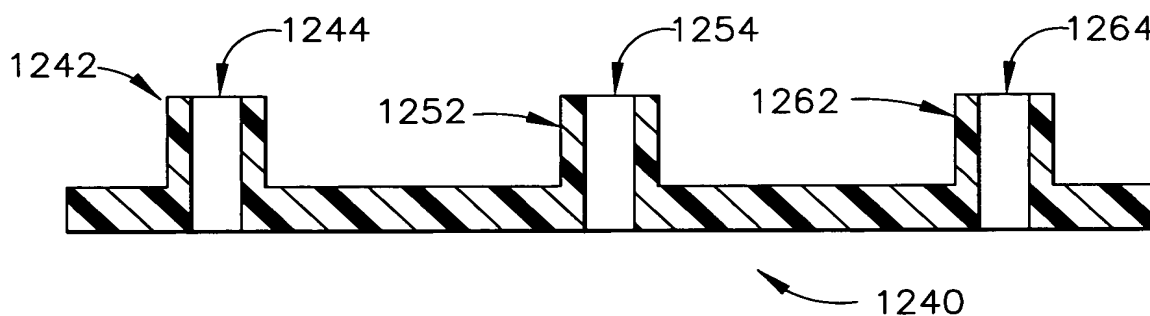


FIG. 55F

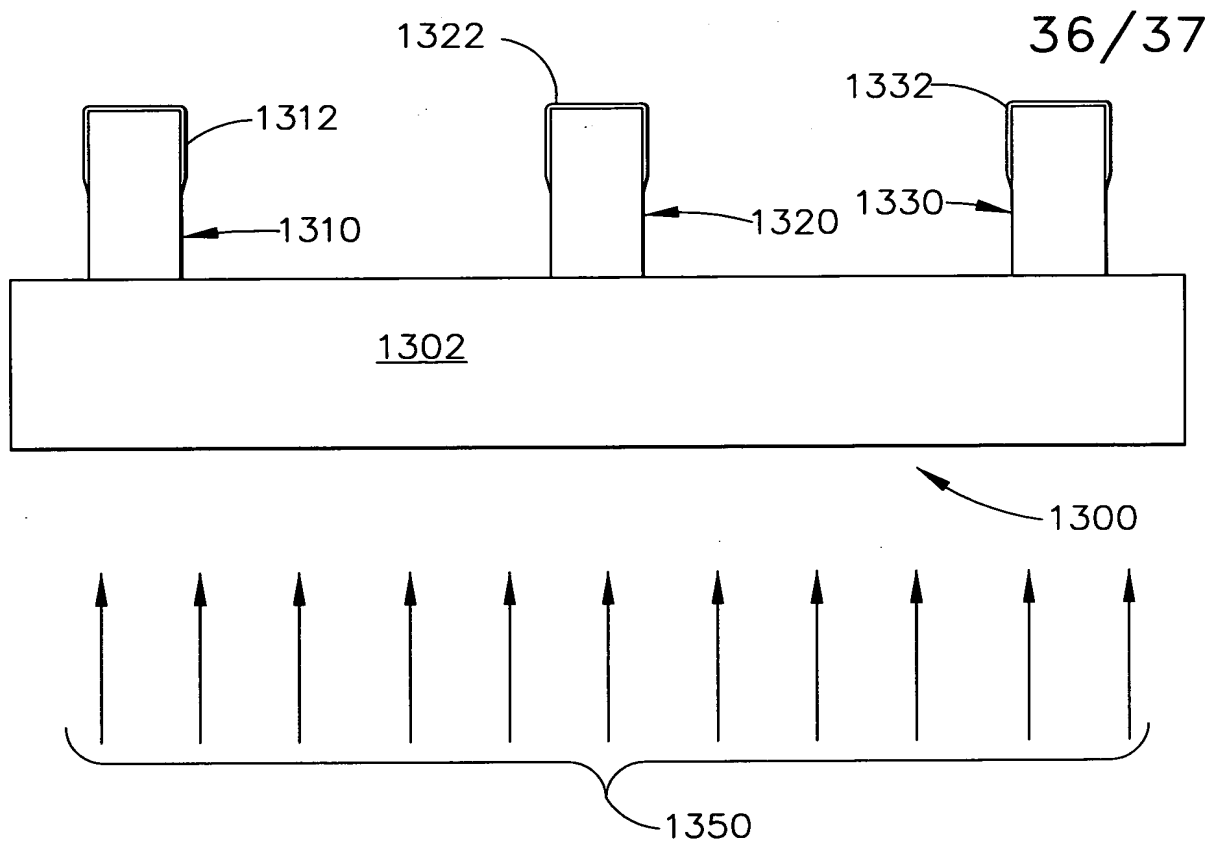


FIG. 56A

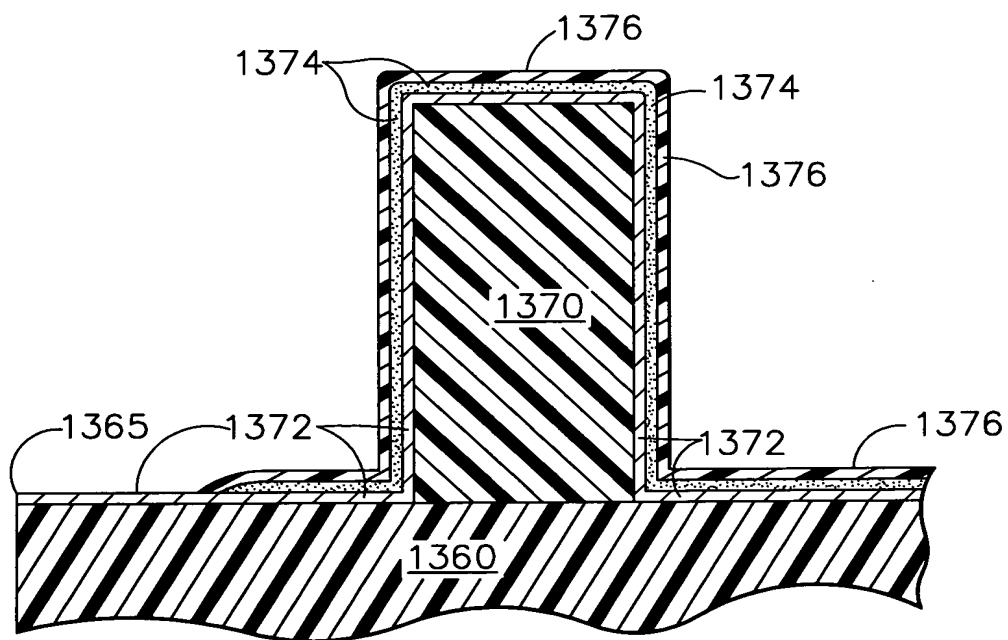


FIG. 56B

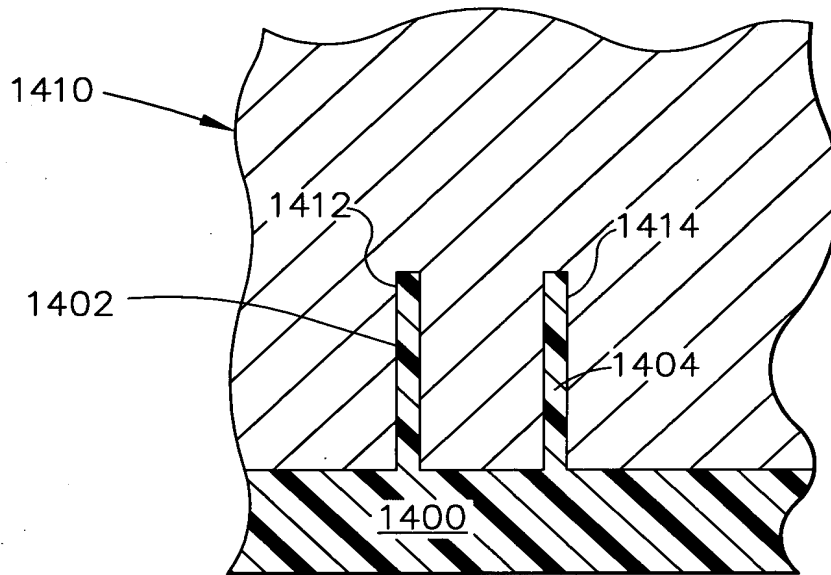


FIG. 57A

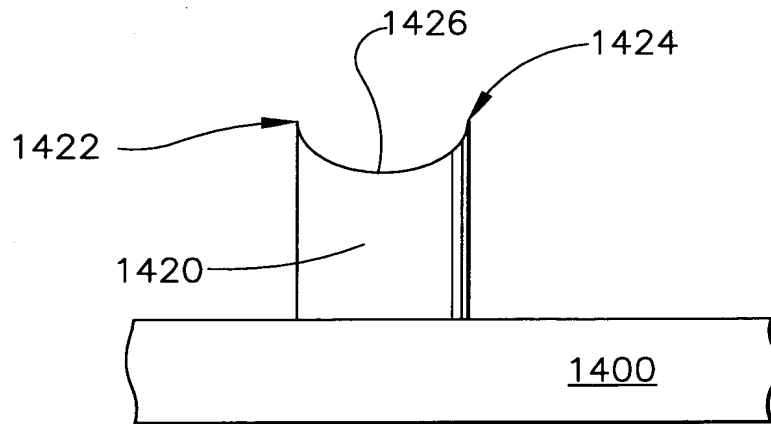


FIG. 57B